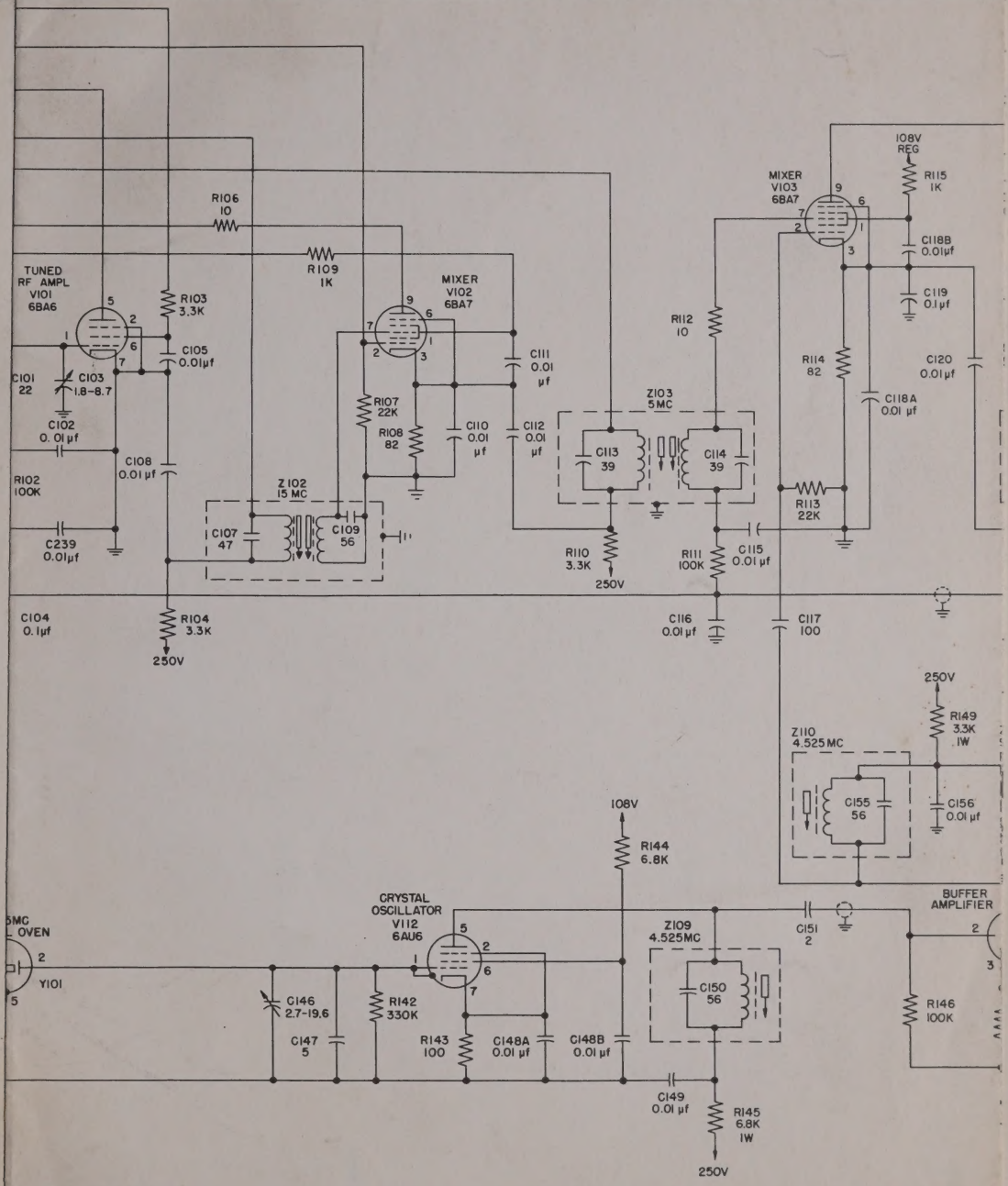
General Microwave 550
WWV Rec.



General Microwave 550
WWV Rec.

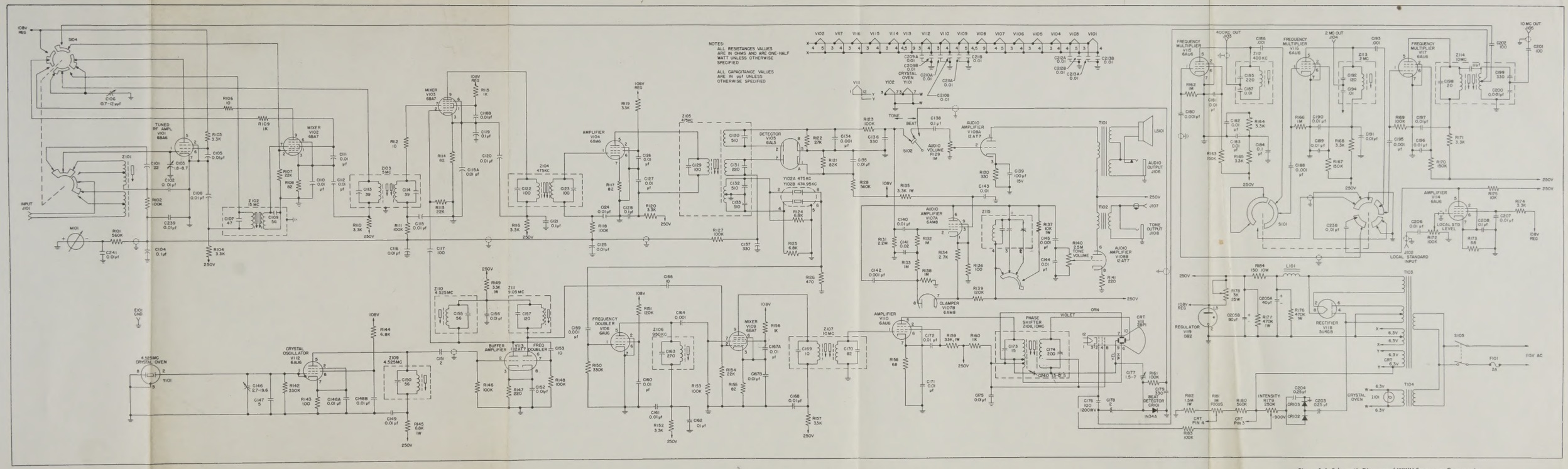


Figure 1-4. Schematic Diagram of WWV Frequency Comparator

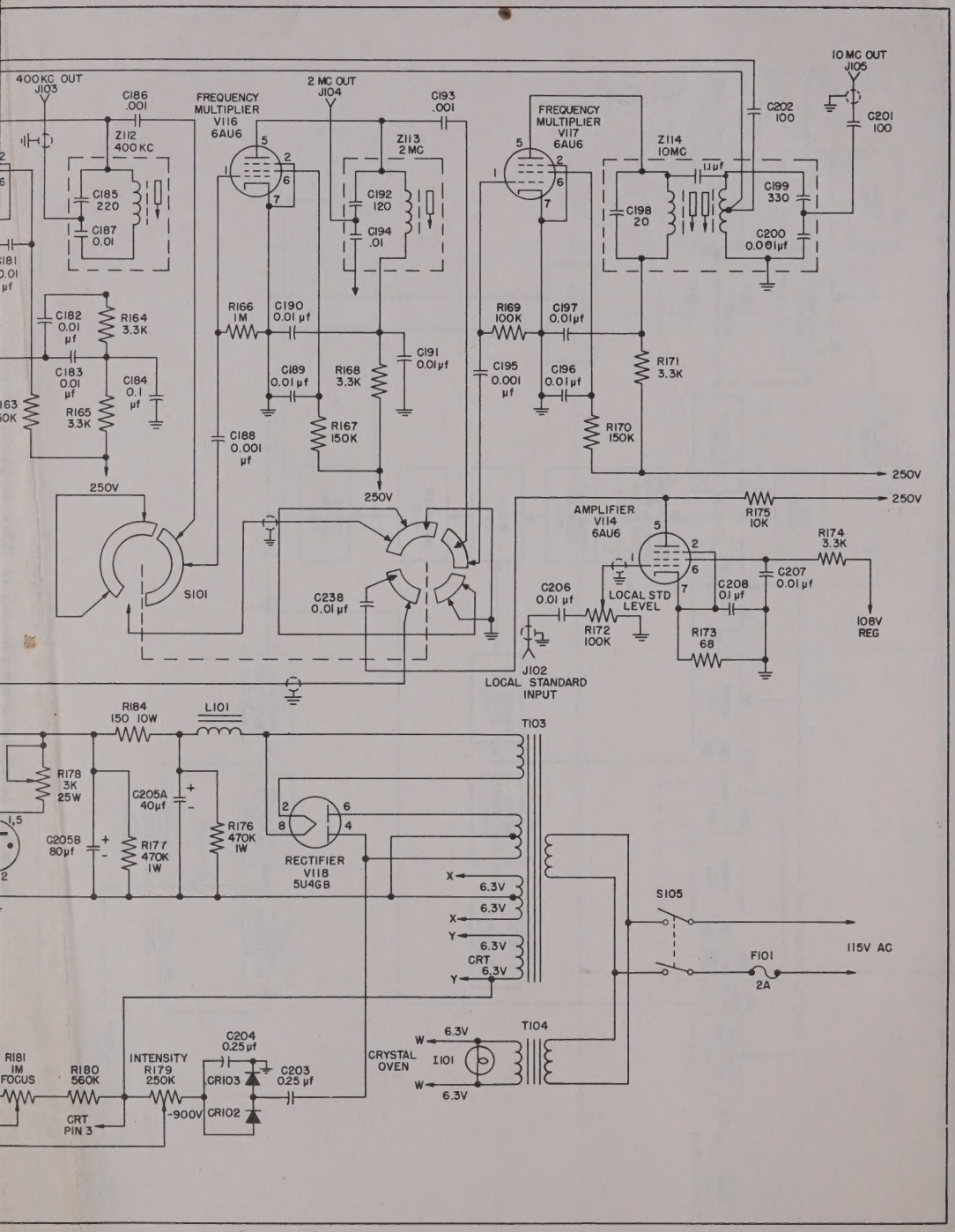


Figure 1-4. Schematic Diagram of WWV Frequency Comparator

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
S104 at 5 MC (cont)	V103 (cont)	7	-0.9	660K	R101, R111, R112, and Z103
		9	210	80K	R116, Z104, and 250-volt supply
	V104	1	-0.9	60K	R101, R118, and Z104
		2	0	0	Wiring to ground
		7		82	R117
		5	210	80K	R120, Z105, and 250-volt supply
		6	93	80K	R119 and 108-volt supply
	V105	1	38.5	220K	R121, R128, and 108-volt supply
		2	-0.14	28K	R122 and Z105
		5	0	0	Wiring to ground
		7	-0.9	660K	R101, R127, and Z105
	V106	1	-0.2	330K	C159 and R150
		2, 7	0	0	Wiring to ground
		5	230	80K	R152, Z106, and 250-volt supply
		6	38	200K	C160, R151, and 108-volt supply
	V107	1, 9	0.985	100	R134, R136, and R139
		2	-0.01	3M	R132, R133, and R138
		3	102	80K	C143, R135, and 108-volt supply
		6	240	75K	C142, Z115, and 250-volt supply
		7	6	3K	R134, R136, R139, and 250-volt supply
		8	0	1M	C142 and R138
	V114	1	-0.12	0-100K	R172
		2, 7	0.52	68	R173
		5	180	90K	R175 and 250-volt supply
		6	99	80K	C207, R174, and 108-volt supply
	V115	1	-0.35	1M	R162
		2, 7	0	0	Wiring to ground

Figure 1-9. Voltage and Resistance Chart (Sheet 3 of 5)

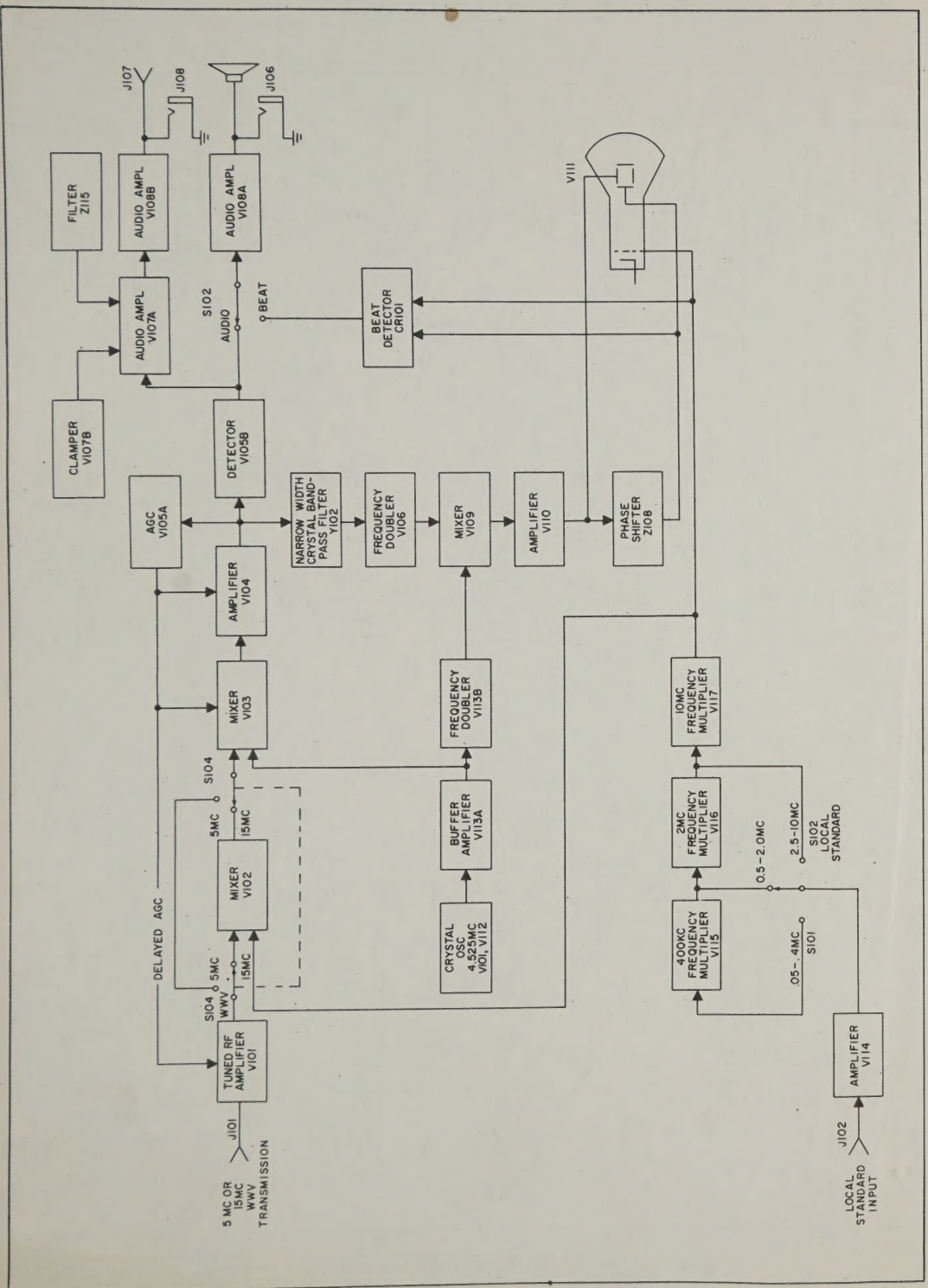


Figure 1-3. Functional Block Diagram of WWV Frequency Comparator

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
S104 at 5 MC (cont)	V103 (cont)	7	-0.9	660K	R101, R111, R112, and Z103
		9	210	80K	R116, Z104, and 250-volt supply
	V104	1	-0.9	60K	R101, R118, and Z104
		2	0	0	Wiring to ground
		7		82	R117
		5	210	80K	R120, Z105, and 250-volt supply
		6	93	80K	R119 and 108-volt supply
	V105	1	38.5	220K	R121, R128, and 108-volt supply
		2	-0.14	28K	R122 and Z105
		5	0	0	Wiring to ground
		7	-0.9	660K	R101, R127, and Z105
	V106	1	-0.2	330K	C159 and R150
		2, 7	0	0	Wiring to ground
		5	230	80K	R152, Z106, and 250-volt supply
		6	38	200K	C160, R151, and 108-volt supply
	V107	1, 9	0.985	100	R134, R136, and R139
		2	-0.01	3M	R132, R133, and R138
		3	102	80K	C143, R135, and 108-volt supply
		6	240	75K	C142, Z115, and 250-volt supply
		7	6	3K	R134, R136, R139, and 250-volt supply
		8	0	1M	C142 and R138
	V114	1	-0.12	0-100K	R172
		2, 7	0.52	68	R173
		5	180	90K	R175 and 250-volt supply
		6	99	80K	C207, R174, and 108-volt supply
	V115	1	-0.35	1M	R162
		2, 7	0	0	Wiring to ground

Figure 1-9. Voltage and Resistance Chart (Sheet 3 of 5)

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
S104 at 5 MC (cont)	V115 (cont)	5	225	80K	R164, R165, Z112, and 250-volt supply
		6	68	220K	C181, R163, and 250-volt supply
	V116	1	-0.38	1M	R166
		2, 7	0	0	Wiring to ground
		5	235	80K	R168, Z113, and 250-volt supply
		6	65	220K	C189, R167, and 250-volt supply
	V117	1	-0.22	100K	R169
		2, 7	0	0	Wiring to ground
		5	235	80K	C197, R171, Z114, and 250-volt supply
		6	67	220K	C196, R170, and 250-volt supply
	V118	2, 8	295	70K	C205A, C205B, L102, R176, R117, R185, and T103
		4, 6	380(AC)	110	T103
	V119	1, 5	108	80K	R178, V119, and 250-volt supply
		2	0	0	Wiring to ground
WARNING Do not measure voltage at pins of cathode-ray tube V111 without high-voltage probes.					
INTENSITY and FOCUS controls fully counter-clockwise	V111	1, 12	-840	3M	T103
		2	-900	3.4M	C203, C204, C176, CR102, CR103, R179, R180, R181, R182, R183, and T103
		3	-840	3M	T103

Figure 1-9. Voltage and Resistance Chart (Sheet 4 of 5)

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
INTENSITY and FOCUS controls fully counter-clockwise (cont)	V111 (cont)	4	-700	2.5M	C203, C204, CR102, CR103, R179, R180, R181, and T103
		6, 7, 8, 9, 10	230	80K	R160, Z108, and 250-volt supply

Figure 1-9. Voltage and Resistance Chart (Sheet 5 of 5)

NOMENCLATURE	PART NUMBER OR MODEL	APPLICATION	RANGE	ACCURACY
Signal generator	General Radio Model 1001-A	Variable frequency source	5 kc to 50 mc	±1 percent
Vacuum tube voltmeter	Ballantine Model 300G	Audio-frequency voltage measurements	1 mv to 1000 v	±2 percent
Vacuum tube voltmeter	Ballantine Model 317	Radio-frequency voltage measurements and counter preamplifier	1 mv to 300 v	±5 percent
Power divider	Microlab Model DB-3	Signal generator output junction	Not applicable	±1/2 db
Frequency counter	Hewlett-Packard Model 1001-A	Determine frequency output of signal generator	10 cps to 10.1 mc	5 parts in 10^8 stability/week
Audio oscillator	Hewlett-Packard Model 200CD	Variable audio-frequency source	5 cps to 600 kc	±2 percent
Attenuator	General Microwave Corp. Model D150	Vary signal-generator output level to comparator	0 to 41 db	±0.1 db/10 db
Attenuator	General Microwave Corp. Model D150-S1	Vary signal-generator output level to comparator	0 to 70 db	±0.1 db/10 db
50-ohm, 1/2-watt resistor (3 required)	Ohmite MIL Type RC-20	Resistive matching loads	Not applicable	±5 percent
600-ohm, 1/2-watt resistor	Ohmite MIL Type RC-20	Resistive matching load	Not applicable	±5 percent

Figure 1-10. Calibration Equipment

of the internal adjustments referenced in figure 1-11. After completing the calibration procedure, the comparator must be tested in accordance with the instructions in paragraphs 1-35 through 1-41 to check that the comparator is functioning correctly. Figures 1-14 and 1-15 show the setups used to test calibration accuracy.

1-33. PRELIMINARY PROCEDURE.

a. Set all controls to their off or fully counterclockwise position.

b. Connect comparator to a source of 115-volt, 60-cycle, single-phase power.

c. Set POWER switch to ON, and check that power indicator lamp glows. Allow 5 minutes for comparator to reach operating temperature.

1-34. CALIBRATION PROCEDURE. To calibrate the comparator, follow the procedure of figure 1-11. Connect the low side of the signal-generator output cable to chassis ground. Where the use of a vacuum tube voltmeter is indicated, connect the positive lead of Ballantine Model 300G to the specified point, and connect the negative lead to chassis ground.

1-35. CALIBRATION TESTS. The tests described in paragraphs 1-36 through 1-41 should be performed after calibration of the comparator, to determine whether it is functioning correctly. For all calibration tests, the comparator must be connected to a source of 115-volt, 60-cycle power, and the TONE VOLUME and AUDIO VOLUME controls must be set fully clockwise.

STEP	TO ALIGN	SIGNAL GENERATOR FREQUENCY AND OUTPUT LEVEL	INSERTION POINT	VACUUM TUBE VOLTMETER CONNECTION	PROCEDURE
1	Z107	10 mc, 0.1v	XV109, pin 7	-----	Adjust primary and secondary of Z107 for maximum signal on cathode-ray tube.
2	Z108	10 mc, 0.1v	XV109, pin 7	-----	Adjust primary of Z108 for maximum signal amplitude on cathode-ray tube. Adjust secondary of Z108, and C240, for circular pattern on cathode-ray tube.
3	Z109	-----	-----	XV113, pin 2	Set LOCAL OSC TRIMMER control C146 to midrange position. Rotate slug of Z109 counterclockwise until minimum voltage reading is obtained. Rotate slug clockwise to obtain 1.8-volt reading on vacuum tube voltmeter.
4	Z110	-----	-----	XV113, pin 7	Adjust Z110 for maximum voltage reading on vacuum tube voltmeter.
5	Z111	-----	-----	XV109, pin 2	Adjust Z111 for maximum voltage reading on vacuum tube voltmeter (approximately 7 volts).
6	Z106	950 kc, 0.01 v	XV106, pin 1	-----	Adjust Z106 for maximum response on cathode-ray tube.

Figure 1-11. Calibration Procedures (Sheet 1 of 2)

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-35	S2001-1	. SHIELD, Cathode-ray tube (99813)	1	
-36	2BP1	. TUBE, Cathode-ray (49675)	1	
-37	COMM	. RESISTOR, FIXED, COMPOSITION, 1.5 meg, ± 10%, 1 W	1	
-38	1596	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-39	1505	. TRANSFORMER, Output	1	
		(ATTACHING PARTS)		
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-40	SP35A	. LOUDSPEAKER (80331)	1	
		(ATTACHING PARTS)		
	CS211-66	. SCREW, MACHINE, PAN HEAD, CROSS- RECESSED	4	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	4	
		---*---		
-41	1537	. FILTER, Audio	1	
		(ATTACHING PARTS)		
	CS210-66	. SCREW, MACHINE, PAN HEAD, SLOTTED	4	
	1106-00	. LOCKWASHER, EXTERNAL TOOTH (78189)	4	
		---*---		
-42	6AM8	. ELECTRON TUBE, Diode-pentode (82219)	1	
-43	1597	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-44	1504	. TRANSFORMER, Power	1	
		(ATTACHING PARTS)		
	CS210-88	. SCREW, MACHINE, PAN HEAD, CROSS- RECESSED	4	
	CS270-3	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	4	
		---*---		
-45	9464-12	. SOCKET, TUBE, Duodecal (71785)	1	
-46	13A12564	. SHIELD, ELECTRON TUBE (71785)	1	
-47	OB2	. ELECTRON TUBE, Voltage regulator (97966)	1	
-48	5U4GB	. ELECTRON TUBE, Rectifier (97966)	1	
-49	16169	. HOLDER, TUBE (71785)	1	
-50	0379	. RESISTOR, ADJUSTABLE, Wirewound, 3K, ± 10%, 25 W (supplied with mounting brackets) (44655)	1	
		(ATTACHING PARTS)		
	CS210-66	. SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-50A	1513-A	. TERMINAL STRIP, 2-lug (71785)	3	
-50B	1442	. SHIELD, CAPACITOR	1	
-51	1446	. BRACKET, SWITCH	1	
-52	SB-375-4	. BUSHING, SNAP (28520)	4	
-53	1508	. COIL, Single-tuned (supplied with mounting hardware)	1	
-54	31811	. CABLE, 3-conductor, 0.330 in. nominal OD by 6 ft lg (90816)	1	
	MS24663	. CONNECTOR, PLUG, ELECTRICAL	1	
	SR-6P-1	. STRAIN RELIEF (28520)	1	

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-55	CG	. CAPACITOR, CERAMIC DISC, 0.01 uf, GMV. . . 500 vdcw (71590)	37	
-56	CG	. CAPACITOR, CERAMIC DISC, 1000 uuf, GMV, . . 500 vdcw (71590)	10	
-57	CG	. CAPACITOR, CERAMIC DISC, 0.02 uf, GMV, . . 500 vdcw (71590)	1	
-58	BYD6DS1	. CAPACITOR, CERAMIC DISC, 2-section, 0.01 . . uf, GMV, 600 vdcw each section (14655)	8	
-59	CD15C220J300	. CAPACITOR, SILVER MICA, 22 uuf ±5%, 300 . . vdcw (14655)	1	
-60	CD15E101J300	. CAPACITOR, SILVER MICA, 100 uuf ±5%, 300 . . vdcw (14655)	3	
-61	CD15E331J300	. CAPACITOR, SILVER MICA, 330 uuf ± 5%, 300 . vdcw (14655)	2	
-62	CD15C050K	. CAPACITOR, SILVER MICA, 5 uuf ±10%, 500 . . vdcw (14655)	1	
-63	CD15C020K	. CAPACITOR, SILVER MICA, 2 uuf ±10%, 500 . . vdcw (14655)	1	
-64	CD15C100K300	. CAPACITOR, SILVER MICA, 10 uuf ±10%, 300 . . vdcw (14655)	2	
-65	BBR100-15	. CAPACITOR, ELECTROLYTIC, 100 uf, 15. . . . vdcw (14655)	1	
-66	160P10494	. CAPACITOR, PAPER, 0.1 uf ± 10%, 400 vdcw . . (80183)	8	
-67	VC-11G	. CAPACITOR, VARIABLE, GLASS, 0.7 to 12 . . . uuf, 1K vdcw (73899)	1	
-68	FT9	. FEED-THRU (80035)	2	
-69	334	. LUG, SOLDER, with 0.375 in. dia hole (79963) . .	3	
-70	SE3L30H	. RECTIFIER, METALLIC, 780V AC input, 1.5 . . MA DC output (73506)	2	
-71	COMM	. RESISTOR, FIXED, COMPOSITION, 560K ±10%, . 1/2 W	1	
-72	COMM	. RESISTOR, FIXED, COMPOSITION, 100K ±10%, . 1/2 W	8	
-73	COMM	. RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, . 1/2 W	12	
-74	COMM	. RESISTOR, FIXED, COMPOSITION, 1 meg, . . . ±10%, 1/2 W	5	
-75	COMM	. RESISTOR, FIXED, COMPOSITION, 10 ohms . . ±10%, 1/2 W	2	
-76	COMM	. RESISTOR, FIXED, COMPOSITION, 22K ±10%, . 1/2 W	3	
-77	COMM	. RESISTOR, FIXED, COMPOSITION, 82 ohms . . ±10%, 1/2 W	3	
-78	COMM	. RESISTOR, FIXED, COMPOSITION, 1K ±10%, . . 1/2 W	4	
-79	COMM	. RESISTOR, FIXED, COMPOSITION, 82K±10%, . 1/2 W	1	
-80	COMM	. RESISTOR, FIXED, COMPOSITION, 330K ±10%, . 1/2 W	2	
-81	COMM	. RESISTOR, FIXED, COMPOSITION, 27K ±10%, . 1/2 W	1	
-82	COMM	. RESISTOR, FIXED, COMPOSITION, 6.8K ±10%, . 1/2 W	3	
-83	COMM	. RESISTOR, FIXED, COMPOSITION, 330 ohms . . ±5%, 1/2 W	1	
-84	COMM	. RESISTOR, FIXED, COMPOSITION, 2.2 meg. . . ±10%, 1/2 W	1	
-85	COMM	. RESISTOR, FIXED, COMPOSITION, 2.7K ±5%, . 1/2 W	1	
-86	COMM	. RESISTOR, FIXED, COMPOSITION, 3.3K ±5%, . 1 W	3	

T.O. 33A1-5-125-1

TECHNICAL MANUAL

INSTRUCTIONS AND PARTS BREAKDOWN

FOR

WWV FREQUENCY COMPARATOR

MODEL NO. 550

(GENERAL MICROWAVE CORPORATION)

Contract AF33(604)-35260

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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1 FEBRUARY 1962

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Figure 1-1. WWV Frequency Comparator, Model 550

SECTION I

USE AND MAINTENANCE

1-1. INTRODUCTION.

1-2. Section I of this technical manual contains information for operating and servicing the WWV Frequency Comparator, Model 550, manufactured by the General Microwave Corporation, Farmingdale, Long Island, New York, under contract No. AF33(604)-35260. To facilitate the presentation of information, the WWV Frequency Comparator will be referred to as the comparator.

1-3. PURPOSE OF EQUIPMENT.

1-4. The comparator (see figure 1-1) is used to check the accuracy of a signal (local standard) by comparing it with a signal which is known to be accurate. The comparator is capable of accepting subharmonics of 400-kilocycle, 2-megacycle, or 10-megacycle signals. The multiple of the subharmonic nearest 10 megacycles is compared with a standard 10-megacycle signal derived from the 5- or 15-megacycle transmission from the National Bureau of Standards. Frequency deviations can be monitored as an audible beat for relatively large deviations or, for small deviations, as a rotating pattern on the screen of the comparator's cathode-ray tube.

1-5. DESCRIPTION.

1-6. PHYSICAL CHARACTERISTICS. The comparator is composed of frequency-multiplier circuits, a two-channel superheterodyne receiver, audio and video monitoring circuits, and a regulated power supply. All components are mounted on a single chassis. The comparator can be used as a portable unit or it can be installed in a standard 19-inch relay rack. See figure 1-2 for the principal features and characteristics of the comparator.

Physical	
Height	9-15/16 inches
Width	19-5/8 inches
Depth	15 inches
Weight	42 pounds
Electrical	
Power Input	115 volts ±10 percent, 60 cycles, 138 watts
WWV Frequencies	5.0 and 15.0 megacycles
Local Standard Frequencies	Any subharmonic of 400 kilocycles, 2.0 megacycles, or 10.0 megacycles
Resolution	1 part in 10^7 with 5.0-megacycle WWV transmission; 3.3 parts in 10^8 with 15.0-megacycle WWV transmission
Sensitivity	Better than 1.0 microvolt
Image Rejection	Approximately 80 decibels
Frequency Outputs	400 kilocycles, 2.0 megacycles, and 10.0 megacycles (multiples of local standard)
Audio Outputs	Normal modulation of WWV transmission; also, 440-, 600-, and 1000-cycle standard tone outputs

Figure 1-2. Leading Particulars

1-7. PRINCIPLES OF OPERATION.

1-8. BASIC PRINCIPLES. To obtain a comparison signal for use as a standard, the comparator receives either the 5- or 15-megacycle WWV transmission of the National Bureau of Standards and converts it to a signal which is a pure 10-megacycle sine wave. This 10-megacycle signal is applied to the four deflection plates of the cathode-ray tube; however, the phase of the signal applied to the horizontal deflection plates is shifted 90 degrees from the signal on the vertical deflection plates. A resultant circular trace is formed by an electron beam rotating ten million times per second.

1-9. The signal being checked for accuracy is converted to 10 megacycles and is applied to the control grid of the cathode-ray tube, thereby intensifying the rotating electron beam during the positive half of each cycle of the signal. As a result, the circular trace has an intensified segment. This segment remains stationary only if the converted signal on the control grid is exactly 10 megacycles. Any deviation of the converted signal from 10 megacycles is indicated by rotation of the intensified segment of the trace, at a rate determined by the inaccuracy of the converted signal. If the intensified segment of the trace rotates clockwise, the frequency of the signal being checked for accuracy is too high. If the intensified segment of the trace rotates counterclockwise, the frequency of the signal being checked is too low.

1-10. DETAILED OPERATION. Paragraphs 1-11 through 1-14 cover comparator operation with reception of a 5-megacycle signal from the National Bureau of Standards. Paragraph 1-15 deals with reception of a 15-megacycle signal. See figure 1-3 for a functional block diagram of the comparator; figure 1-4, for a detailed schematic.

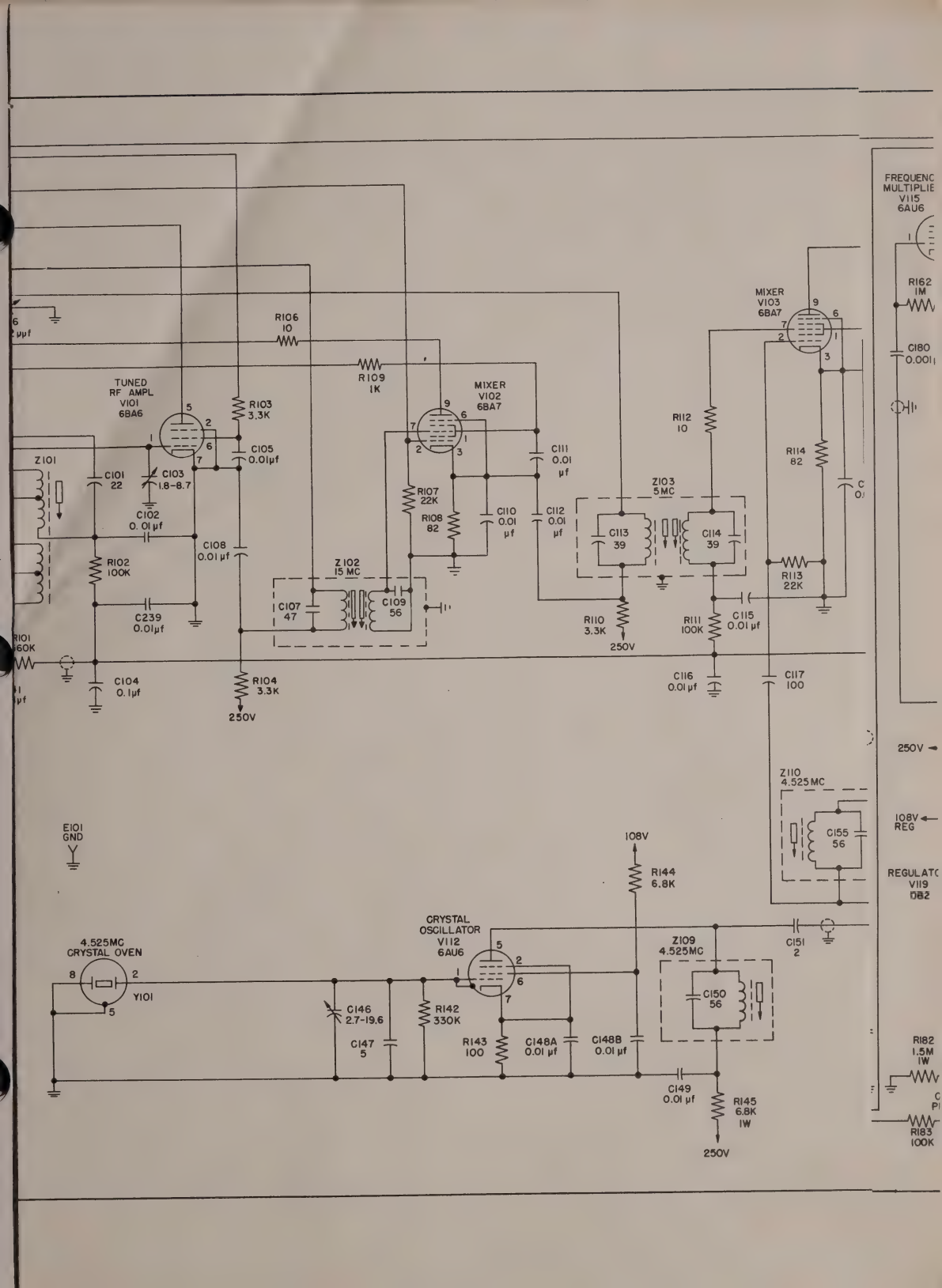
1-11. The 5-megacycle WWV transmission from the National Bureau of Standards is received by the antenna and is applied to ANT INPUT receptacle J101. The signal is fed into a tuned rf stage which provides preselection and amplification. When WWV SELECTOR switch S104 is set for 5-megacycle reception, the 5-megacycle signal is fed directly to second-stage mixer V103. Mixer V103 also receives a 4.525-megacycle signal from the local crystal oscillator and buffer amplifier stages. The output of mixer V103 is the difference between the two input signals, or 0.475 megacycle plus any error derived from inaccuracy of the local crystal oscillator. This output signal is applied to amplifier V104 and fed to the automatic gain control circuit, to the detector, and to the narrow-bandpass crystal filter. A portion of the output of amplifier V104, which is detected by V105A, is filtered and returned to the grids of tuned rf amplifier V101, mixer V103, and amplifier V104 to stabilize the output level of the receiver. Another portion of the output of amplifier V104 is demodulated by detector V105B. When AUDIO SELECTOR switch S102 is set to AUDIO to permit the demodulated signal to reach audio amplifier V108A, the signal is amplified and fed to the comparator's speaker.

1-12. The remaining portion of the output of amplifier V104 is fed to narrow-bandpass crystal filter Y102. This filter passes a signal of 0.475 megacycle ±50 cycles. The output of filter Y102 is doubled in frequency doubler V106 to produce 0.950 megacycle plus double the error of the local crystal oscillator frequency. It is then fed to mixer V109. Mixer V109 also receives a signal generated by the local crystal oscillator and doubled by frequency doubler V113B. This signal has a frequency error equal to twice the local crystal oscillator error, but of opposite polarity to that present at frequency doubler V106. The errors in the two signals therefore cancel each other, and the resultant signal output of mixer V109 is a pure 10-megacycle sine wave. This 10-megacycle signal is coupled to amplifier V110. A portion of the output of amplifier V110 is applied to the vertical deflection plates of cathode-ray tube V111. The phase of the remainder of the output is shifted 90 degrees by phase shifter Z108 and is applied to the horizontal deflection plates. The resultant circular trace is formed by an electron beam rotating ten million times per second.

1-13. The signal to be checked is applied to LOCAL STANDARD INPUT jack J102, and then to input amplifier V114. This input frequency must be a subharmonic of 400 kilocycles, 2 megacycles, or 10 megacycles. The output of amplifier V114 is applied initially to one of the three multiplier stages. The number of stages used is determined by the input frequency of the signal being checked. The output of the multiplier stages is approximately a 10-megacycle signal. The frequency deviation present is proportional to the error in the input signal. The approximate 10-megacycle signal is fed to beat detector CR101 where it is combined with the 10-megacycle signal from phase shifter Z108. The result is a beat frequency equal to the difference between the standard (WWV) signal and the converted local standard signal being checked.

1-14. With AUDIO SELECTOR switch S102 set to BEAT to permit the beat frequency to pass to audio amplifier V108A, an audible beat is heard from the speaker for normal frequency deviations. By listening to the pitch of the audio beat and adjusting the frequency of the signal being checked, the frequency deviation can be decreased. (Decreasing the deviation lowers the pitch of the audio beat.) To completely eliminate frequency deviations, it is necessary to observe the trace on the cathode-ray tube V111. The output of the multiplier stages is applied to the control grid of the cathode-ray tube V111 where it intensity-modulates the electron beam and causes an intensified segment to appear on the trace. The intensified segment rotates once per second for a frequency error of 1 cycle in ten million.

1-15. If a 15-megacycle National Bureau of Standards signal is used, WWV SELECTOR switch S104 is set to bring mixer V102 into the receiver circuit. Mixer V102 receives the 15-megacycle WWV transmission and the approximate 10-megacycle output of frequency multiplier V117. The resultant output is an approximate 5-megacycle signal. From this point in the circuit, signal paths and frequency conversions are identical with those used when a 5-megacycle signal


TUNED RF AMPL V101 6BA6
MIXER V102 6BA7
MIXER V103 6BA7
CRYSTAL OSCILLATOR V112 6AU6
4.525MC CRYSTAL OVEN
Y101
E101 GND
Z101
Z102 15 MC
Z103 5MC
Z109 4.525MC
Z110 4.525MC
R101 60K
R102 100K
R103 3.3K
R104 3.3K
R105 10
R106 10
R107 22K
R108 82
R109 1K
R110 3.3K
R111 100K
R112 10
R113 22K
R114 82
R142 330K
R143 100
R144 6.8K
R145 6.8K 1W
C101 22
C102 0.01 µf
C103 1.8-8.7
C104 0.1µf
C105 0.01µf
C107 47
C108 0.01 µf
C109 56
C110 0.01 µf
C111 0.01 µf
C112 0.01 µf
C113 39
C114 39
C115 0.01 µf
C116 0.01 µf
C117 100
C146 2.7-19.6
C147 5
C148A 0.01 µf
C148B 0.01 µf
C149 0.01 µf
C150 56
C151 2
C155 56
C239 0.01µf
250V
108V
108V REG
FREQUENC MULTIPLIE V115 6AU6
R162 1M
C180 0.001
REGULATO V119 6B2
R182 1.5M 1W
R183 100K

1-7. PRINCIPLES OF OPERATION.

1-8. BASIC PRINCIPLES. To obtain a comparison signal for use as a standard, the comparator receives either the 5- or 15-megacycle WWV transmission of the National Bureau of Standards and converts it to a signal which is a pure 10-megacycle sine wave. This 10-megacycle signal is applied to the four deflection plates of the cathode-ray tube; however, the phase of the signal applied to the horizontal deflection plates is shifted 90 degrees from the signal on the vertical deflection plates. A resultant circular trace is formed by an electron beam rotating ten million times per second.

1-9. The signal being checked for accuracy is converted to 10 megacycles and is applied to the control grid of the cathode-ray tube, thereby intensifying the rotating electron beam during the positive half of each cycle of the signal. As a result, the circular trace has an intensified segment. This segment remains stationary only if the converted signal on the control grid is exactly 10 megacycles. Any deviation of the converted signal from 10 megacycles is indicated by rotation of the intensified segment of the trace, at a rate determined by the inaccuracy of the converted signal. If the intensified segment of the trace rotates clockwise, the frequency of the signal being checked for accuracy is too high. If the intensified segment of the trace rotates counterclockwise, the frequency of the signal being checked is too low.

1-10. DETAILED OPERATION. Paragraphs 1-11 through 1-14 cover comparator operation with reception of a 5-megacycle signal from the National Bureau of Standards. Paragraph 1-15 deals with reception of a 15-megacycle signal. See figure 1-3 for a functional block diagram of the comparator; figure 1-4, for a detailed schematic.

1-11. The 5-megacycle WWV transmission from the National Bureau of Standards is received by the antenna and is applied to ANT INPUT receptacle J101. The signal is fed into a tuned rf stage which provides preselection and amplification. When WWV SELECTOR switch S104 is set for 5-megacycle reception, the 5-megacycle signal is fed directly to second-stage mixer V103. Mixer V103 also receives a 4.525-megacycle signal from the local crystal oscillator and buffer amplifier stages. The output of mixer V103 is the difference between the two input signals, or 0.475 megacycle plus any error derived from inaccuracy of the local crystal oscillator. This output signal is applied to amplifier V104 and fed to the automatic gain control circuit, to the detector, and to the narrow-bandpass crystal filter. A portion of the output of amplifier V104, which is detected by V105A, is filtered and returned to the grids of tuned rf amplifier V101, mixer V103, and amplifier V104 to stabilize the output level of the receiver. Another portion of the output of amplifier V104 is demodulated by detector V105B. When AUDIO SELECTOR switch S102 is set to AUDIO to permit the demodulated signal to reach audio amplifier V108A, the signal is amplified and fed to the comparator's speaker.

1-12. The remaining portion of the output of amplifier V104 is fed to narrow-bandpass crystal filter Y102. This filter passes a signal of 0.475 megacycle ±50 cycles. The output of filter Y102 is doubled in frequency doubler V106 to produce 0.950 megacycle plus double the error of the local crystal oscillator frequency. It is then fed to mixer V109. Mixer V109 also receives a signal generated by the local crystal oscillator and doubled by frequency doubler V113B. This signal has a frequency error equal to twice the local crystal oscillator error, but of opposite polarity to that present at frequency doubler V106. The errors in the two signals therefore cancel each other, and the resultant signal output of mixer V109 is a pure 10-megacycle sine wave. This 10-megacycle signal is coupled to amplifier V110. A portion of the output of amplifier V110 is applied to the vertical deflection plates of cathode-ray tube V111. The phase of the remainder of the output is shifted 90 degrees by phase shifter Z108 and is applied to the horizontal deflection plates. The resultant circular trace is formed by an electron beam rotating ten million times per second.

1-13. The signal to be checked is applied to LOCAL STANDARD INPUT jack J102, and then to input amplifier V114. This input frequency must be a subharmonic of 400 kilocycles, 2 megacycles, or 10 megacycles. The output of amplifier V114 is applied initially to one of the three multiplier stages. The number of stages used is determined by the input frequency of the signal being checked. The output of the multiplier stages is approximately a 10-megacycle signal. The frequency deviation present is proportional to the error in the input signal. The approximate 10-megacycle signal is fed to beat detector CR101 where it is combined with the 10-megacycle signal from phase shifter Z108. The result is a beat frequency equal to the difference between the standard (WWV) signal and the converted local standard signal being checked.

1-14. With AUDIO SELECTOR switch S102 set to BEAT to permit the beat frequency to pass to audio amplifier V108A, an audible beat is heard from the speaker for normal frequency deviations. By listening to the pitch of the audio beat and adjusting the frequency of the signal being checked, the frequency deviation can be decreased. (Decreasing the deviation lowers the pitch of the audio beat.) To completely eliminate frequency deviations, it is necessary to observe the trace on the cathode-ray tube V111. The output of the multiplier stages is applied to the control grid of the cathode-ray tube V111 where it intensity-modulates the electron beam and causes an intensified segment to appear on the trace. The intensified segment rotates once per second for a frequency error of 1 cycle in ten million.

1-15. If a 15-megacycle National Bureau of Standards signal is used, WWV SELECTOR switch S104 is set to bring mixer V102 into the receiver circuit. Mixer V102 receives the 15-megacycle WWV transmission and the approximate 10-megacycle output of frequency multiplier V117. The resultant output is an approximate 5-megacycle signal. From this point in the circuit, signal paths and frequency conversions are identical with those used when a 5-megacycle signal

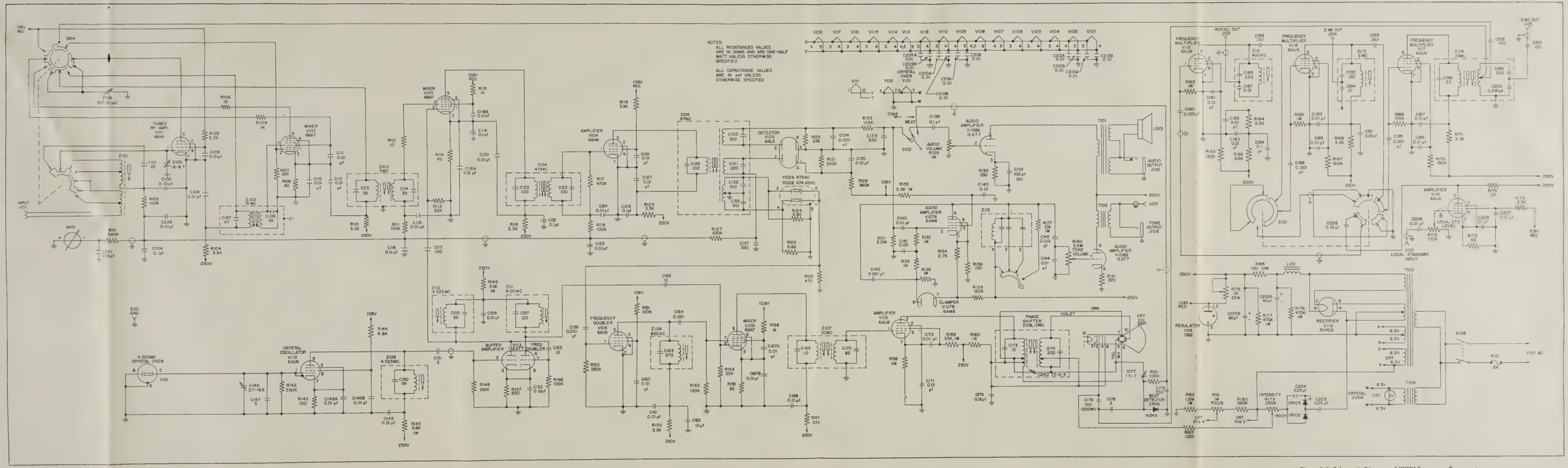


Figure 1-4. Schematic Diagram of WWV Frequency Comparator

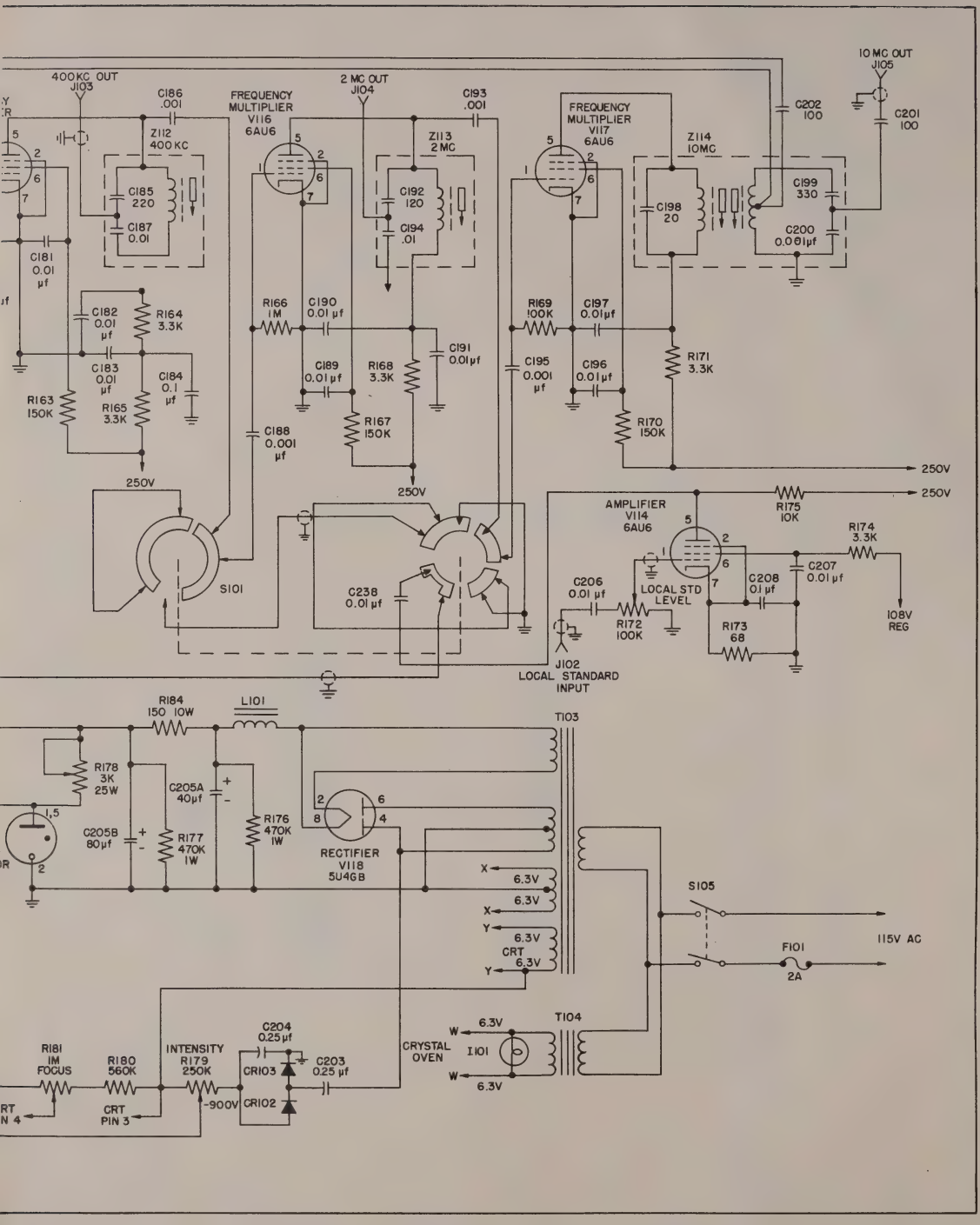


Figure 1-4. Schematic Diagram of WWV Frequency Comparator

is used. However, the signal that reaches the deflection plates of the cathode-ray tube is not a pure 10-megacycle signal, but contains a frequency error twice as great as the error of the signal being checked. The approximate signal applied to the grid of the cathode-ray tube is identical with the signal applied when a 5-megacycle signal is used (10 megacycles plus the frequency error of the signal being checked). Thus, the frequency difference between the signal applied to the deflection plates and the signal applied to the grid is three times as great as when the 5-megacycle signal is used. Therefore, if the intensified segment rotates once per second, it represents a frequency error of 0.33 cycle in ten million.

1-16. PREPARATION FOR USE.

1-17. UNPACKING. The comparator is packed in a double container. The outer container is a wooden packing box secured with nails and a metal strap. The inner container is a fiberboard carton which is stapled and taped closed. Unpack the comparator as follows:

a. Remove metal strap which binds packing box.
b. Pull out nails which secure lid of packing box, and remove lid.
c. Remove cushioning material surrounding inner fiberboard container.
d. Carefully lift out inner container which houses comparator.
e. Pull out staples, and remove tape from top of inner container.
f. Open container, and remove cushioning material.
g. Carefully lift out comparator.
h. Remove tape, and uncoil power cord.

1-18. INSTALLATION. Because the comparator is completely assembled before shipment, no special installation instructions are required. The comparator can be used as a portable unit or it can be mounted in a standard 19-inch relay rack.

1-19. PRELIMINARY SETUP. When the comparator is used for the first time, check the condition of the case, the front panel indicators, and the controls for signs of damage. All damage should be reported to the proper authority. Remove the four front-panel screws and the two screws at the rear which secure the chassis to the case, and pull out the chassis. Check that all tubes are securely mounted in their sockets; then, replace the chassis and mounting screws. Check all controls for smoothness of operation and all knobs for security of attachment. If the comparator passes this inspection, proceed as follows:

a. Set POWER switch to off, and set all controls to fully counterclockwise position.
b. Connect power plug to source of 115-volt, 60-cycle, single-phase power.
c. Perform complete calibration procedure as directed in paragraphs 1-30 through 1-41.

1-20. ANTENNA REQUIREMENTS. A simple dipole antenna using 22- to 26-gage, single-strand copper wire provides satisfactory reception. The overall length of the dipole antenna for 5-megacycle reception is approximately 103 feet; for 15-megacycle reception, approximately 39 feet. The input impedance to the comparator, using a balanced line, is 300 ohms; for an unbalanced line, 75 ohms. The antenna should be erected higher than surrounding obstructions.

1-21. OPERATING INSTRUCTIONS.

1-22. See figures 1-5 and 1-6 for the location of all front panel components and for the function and reference designation of operating controls, indicators, and receptacles. To operate the comparator, proceed as follows:

a. Set all controls to their off or fully counterclockwise position.
b. Connect antenna to ANT INPUT receptacle.
c. Connect power plug to source of 115-volt, 60-cycle, single-phase power.
d. Set POWER switch to ON, and check that power indicator lamp glows. Allow 5 minutes for comparator to reach operating temperature.
e. Set WWV SELECTOR switch to 5 MC or 15 MC, as desired.
f. Adjust ANT TRIMMER control to obtain maximum indication on automatic gain control level meter.
g. Adjust LOCAL OSC TRIMMER control to obtain stable trace on cathode-ray tube.
h. Rotate INTENSITY and FOCUS controls clockwise approximately three-fourths of full rotation.
i. Adjust INTENSITY and FOCUS controls to obtain sharply defined trace.
j. Set AUDIO SELECTOR switch to AUDIO.
k. Rotate AUDIO VOLUME control clockwise until tone or time ticks of station are audible.
l. Connect local standard signal to INPUT connector.
m. Set INPUT RANGE-MC switch to frequency range of local standard signal.
n. Adjust INPUT LEVEL control to obtain optimum blanking pattern. Reduce intensity of trace if blanking pattern does not appear with maximum input level. If blanking pattern still does not appear, frequency error may be too great to be visible. Proceed to next step.
o. Disconnect antenna from ANT INPUT receptacle. Trace on cathode-ray tube should collapse.

Note

If the trace on the cathode-ray tube does not collapse when the antenna is disconnected, the comparator is operating on a spurious harmonic of the local standard. Rotate the INPUT LEVEL control counterclockwise until the trace collapses.

p. Connect antenna to ANT INPUT receptacle.
q. Set AUDIO SELECTOR switch to BEAT. Beat note corresponding to frequency deviation (error) of local standard should be audible.
r. Adjust frequency of local standard to obtain zero beat.
s. Observe cathode-ray tube, and adjust frequency of local standard until intensified segment of trace on cathode-ray tube is as stable as possible.

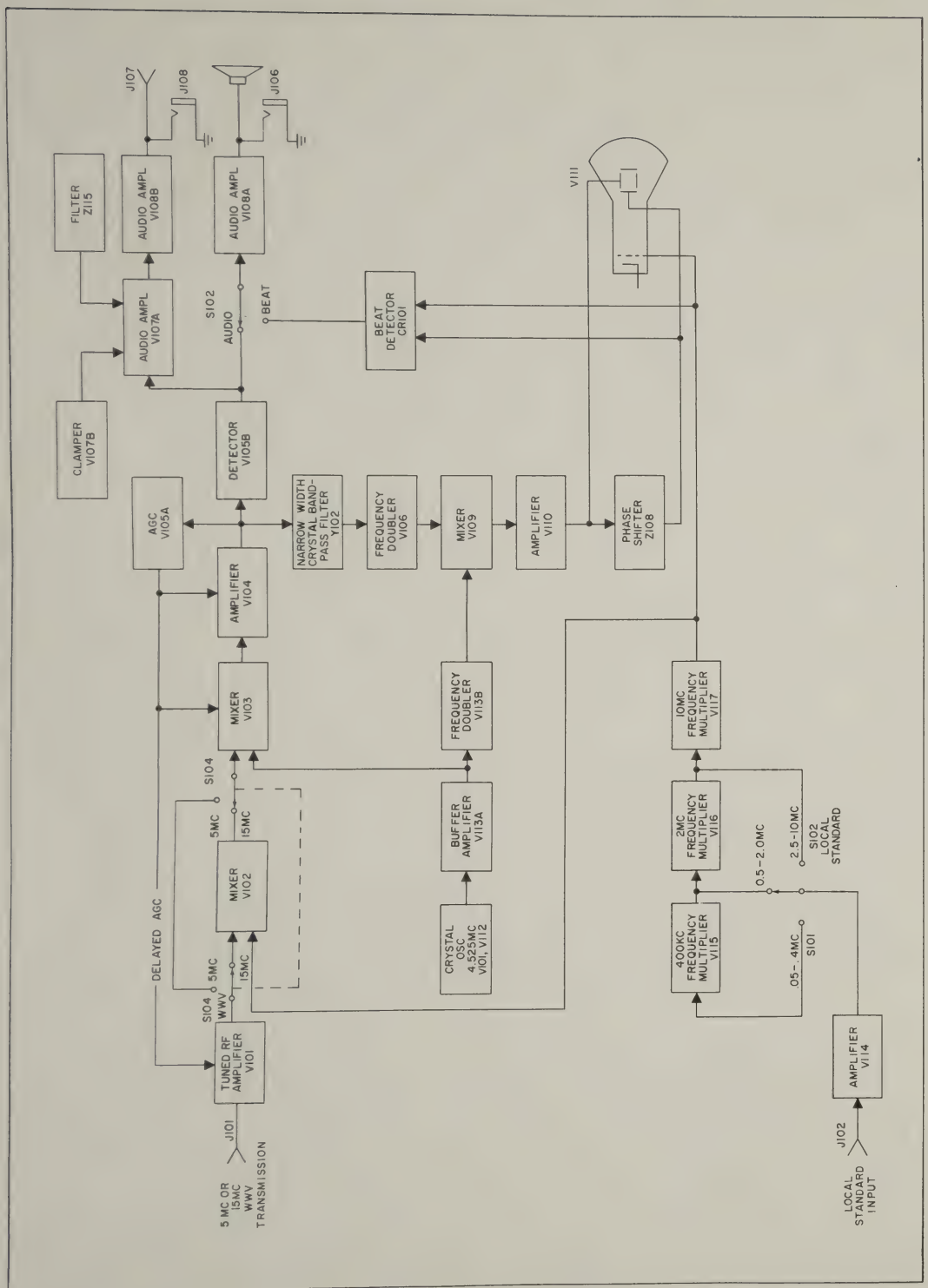


Figure 1-3. Functional Block Diagram of WWV Frequency Comparator

is used. However, the signal that reaches the deflection plates of the cathode-ray tube is not a pure 10-megacycle signal, but contains a frequency error twice as great as the error of the signal being checked. The approximate signal applied to the grid of the cathode-ray tube is identical with the signal applied when a 5-megacycle signal is used (10 megacycles plus the frequency error of the signal being checked). Thus, the frequency difference between the signal applied to the deflection plates and the signal applied to the grid is three times as great as when the 5-megacycle signal is used. Therefore, if the intensified segment rotates once per second, it represents a frequency error of 0.33 cycle in ten million.

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a. Remove metal strap which binds packing box.
b. Pull out nails which secure lid of packing box, and remove lid.
c. Remove cushioning material surrounding inner fiberboard container.
d. Carefully lift out inner container which houses comparator.
e. Pull out staples, and remove tape from top of inner container.
f. Open container, and remove cushioning material.
g. Carefully lift out comparator.
h. Remove tape, and uncoil power cord.

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a. Set POWER switch to off, and set all controls to fully counterclockwise position.
b. Connect power plug to source of 115-volt, 60-cycle, single-phase power.
c. Perform complete calibration procedure as directed in paragraphs 1-30 through 1-41.

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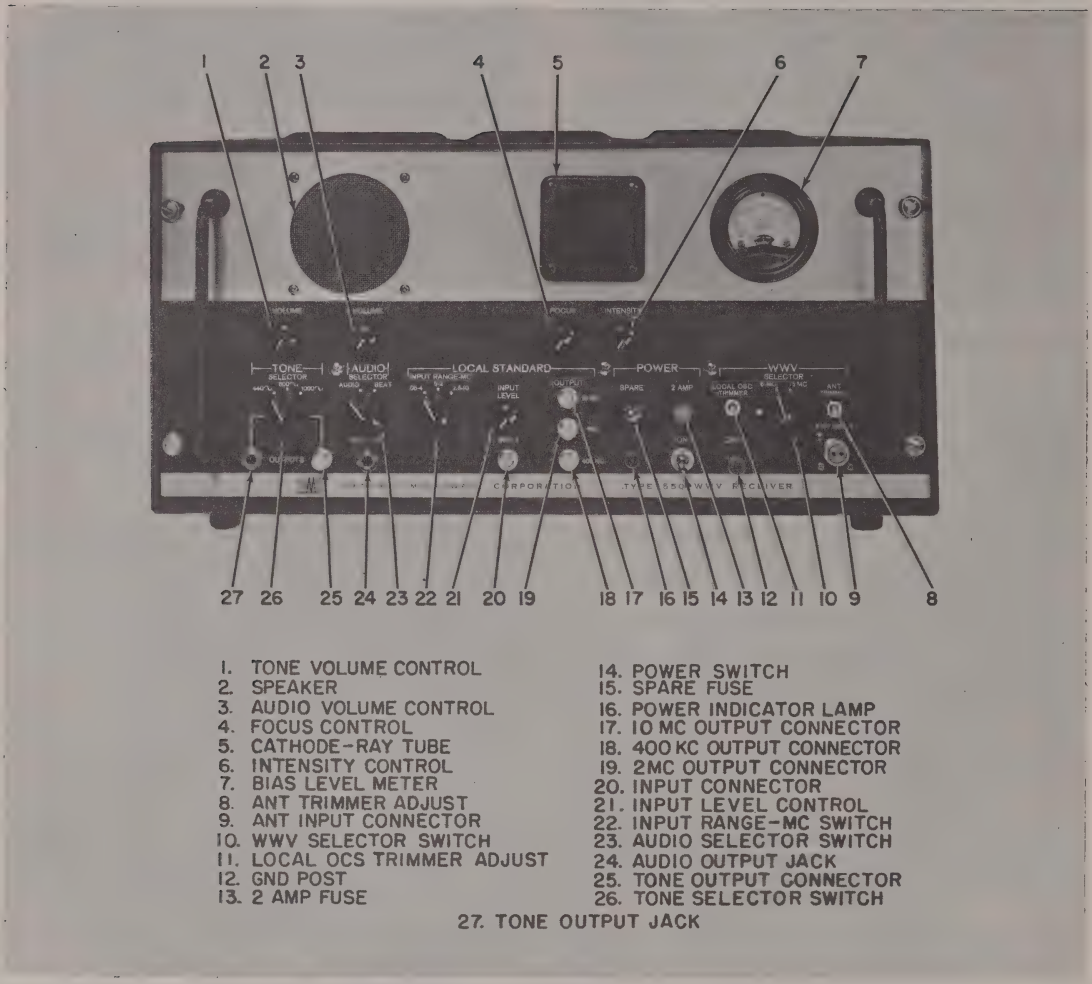
a. Set all controls to their off or fully counterclockwise position.
b. Connect antenna to ANT INPUT receptacle.
c. Connect power plug to source of 115-volt, 60-cycle, single-phase power.
d. Set POWER switch to ON, and check that power indicator lamp glows. Allow 5 minutes for comparator to reach operating temperature.
e. Set WWV SELECTOR switch to 5 MC or 15 MC, as desired.
f. Adjust ANT TRIMMER control to obtain maximum indication on automatic gain control level meter.
g. Adjust LOCAL OSC TRIMMER control to obtain stable trace on cathode-ray tube.
h. Rotate INTENSITY and FOCUS controls clockwise approximately three-fourths of full rotation.
i. Adjust INTENSITY and FOCUS controls to obtain sharply defined trace.
j. Set AUDIO SELECTOR switch to AUDIO.
k. Rotate AUDIO VOLUME control clockwise until tone or time ticks of station are audible.
l. Connect local standard signal to INPUT connector.
m. Set INPUT RANGE-MC switch to frequency range of local standard signal.
n. Adjust INPUT LEVEL control to obtain optimum blanking pattern. Reduce intensity of trace if blanking pattern does not appear with maximum input level. If blanking pattern still does not appear, frequency error may be too great to be visible. Proceed to next step.
o. Disconnect antenna from ANT INPUT receptacle. Trace on cathode-ray tube should collapse.

Note

If the trace on the cathode-ray tube does not collapse when the antenna is disconnected, the comparator is operating on a spurious harmonic of the local standard. Rotate the INPUT LEVEL control counterclockwise until the trace collapses.

p. Connect antenna to ANT INPUT receptacle.
q. Set AUDIO SELECTOR switch to BEAT. Beat note corresponding to frequency deviation (error) of local standard should be audible.
r. Adjust frequency of local standard to obtain zero beat.
s. Observe cathode-ray tube, and adjust frequency of local standard until intensified segment of trace on cathode-ray tube is as stable as possible.



1. TONE VOLUME CONTROL
2. SPEAKER
3. AUDIO VOLUME CONTROL
4. FOCUS CONTROL
5. CATHODE-RAY TUBE
6. INTENSITY CONTROL
7. BIAS LEVEL METER
8. ANT TRIMMER ADJUST
9. ANT INPUT CONNECTOR
10. WWV SELECTOR SWITCH
11. LOCAL OCS TRIMMER ADJUST
12. GND POST
13. 2 AMP FUSE
14. POWER SWITCH
15. SPARE FUSE
16. POWER INDICATOR LAMP
17. 10 MC OUTPUT CONNECTOR
18. 400 KC OUTPUT CONNECTOR
19. 2MC OUTPUT CONNECTOR
20. INPUT CONNECTOR
21. INPUT LEVEL CONTROL
22. INPUT RANGE-MC SWITCH
23. AUDIO SELECTOR SWITCH
24. AUDIO OUTPUT JACK
25. TONE OUTPUT CONNECTOR
26. TONE SELECTOR SWITCH
27. TONE OUTPUT JACK

Figure 1-5. WWV Frequency Comparator Front Panel Components

t. Disconnect local standard from INPUT connector.

u. Disconnect antenna from ANT INPUT receptacle.

v. Set POWER switch to off (down) position.

1-23. MAINTENANCE.

1-24. INSPECTION. Inspect the comparator in accordance with figure 1-7. Parts which do not pass inspection must be repaired or replaced with known good parts. As part of the periodic inspection, the comparator should be calibrated at 1-year intervals.

1-25. CLEANING. The comparator should be thoroughly cleaned at 3-month intervals. Wipe outer surfaces with a clean, lint-free, nylon cloth moistened with solvent, Federal Specification P-S-661, Type II.

Caution

Do not permit the solvent to touch any electrical parts.

1-26. Remove chassis and wipe inner surfaces of the comparator with a soft, dry, lint-free cloth. Using compressed air with a maximum pressure of 20 psi, blow dust from the corners of the chassis and from components mounted on the bottom of the chassis.

1-27. LUBRICATION. No lubrication is required.

ITEM	FIGURE 1-5 INDEX NO.	FUNCTION
TONE VOLUME control (R140)	1	Varies output level of filtered tone output.
AUDIO VOLUME control (R129)	3	Varies output level of speaker.
FOCUS control (R181)	4	Sharpens rotary trace on cathode-ray tube.
Cathode-ray tube (V111)	5	Presents indication of frequency deviation between WWV standard and local standard.
INTENSITY control (R179)	6	Regulates brilliance of trace on cathode-ray tube.
Automatic gain control level meter (M101)	7	Provides indication of automatic gain control level of tuned rf stage.
ANT TRIMMER control (C103)	8	Provides optimum input to tuned rf stage.
ANT INPUT connector (J101)	9	Provides a means for connection of antenna to comparator.
WWV SELECTOR switch (S104)	10	Selects reception of 5- or 15-megacycle WWV transmission from the National Bureau of Standards.
LOCAL OSC TRIMMER control (C146)	11	Adjusts frequency of local oscillator.
POWER switch (S105)	14	Energizes or deenergizes comparator.
Power indicator lamp	16	Indicates application of power to comparator.
10 MC OUTPUT connector (J105)	17	Provides 10-megacycle output when local standard is a subharmonic of 10 megacycles.
400 KC OUTPUT connector (J103)	18	Provides 400-kilocycle output when local standard is a subharmonic of 400 kilocycles.
2 MC OUTPUT connector (J104)	19	Provides 2-megacycle output when local standard is a subharmonic of 2 megacycles.
INPUT connector (J102)	20	Provides a means for connection of local standard to comparator.
INPUT LEVEL control (R172)	21	Varies input level of local standard.
INPUT RANGE-MC switch (S101)	22	Selects frequency multiplier(s) to convert local standard to 10 megacycles.
AUDIO SELECTOR switch (S102)	23	When set to AUDIO, provides WWV modulation; when set to BEAT, provides beat note corresponding to local standard frequency deviation.
AUDIO OUTPUT jack (J106)	24	Provides broadband 600-ohm phone output of WWV modulation.

Figure 1-6. Function of Operating Controls, Indicators, and Receptacles (Sheet 1 of 2)

ITEM	FIGURE 1-5 INDEX NO.	FUNCTION
TONE OUTPUT connector (J107)	25	Provides noise-free 600-ohm phone output of WWV 440-, 600-, or 1000-cycle modulation, depending on setting of switch S103.
TONE SELECTOR switch (S103)	26	Selects 440-, 600-, or 1000-cycle modulation for presentation at phone jack J108 and connector J107.
TONE OUTPUT jack (J108)	27	Provides noise-free 600-ohm phone output of WWV 440-, 600-, or 1000-cycle modulation, depending on setting of switch S103.

Figure 1-6. Function of Operating Controls, Indicators, and Receptacles (Sheet 2 of 2)

COMPONENT	INSPECT FOR	INTERVAL
Controls and switches	Ease of rotation, positive action, looseness of knobs.	30 days
Indicator lamp	Proper operation.	30 days
Meter	Broken glass, bent pointer, mechanical zero-setting.	30 days
Electrical connectors	Damaged inserts, pins, insulating material; spread, corroded, loose, or shorted terminals; mechanical security.	90 days
Electrical parts	Wear, corrosion, dents, cracks, breaks, and discoloration.	90 days
Electron tubes	Mutual conductance, shorts, gas, cracked envelopes, and bent or broken pins.	90 days
Solder joints	Breaks and otherwise defective joints.	180 days

Figure 1-7. Periodic Inspection Requirements

1-28. TROUBLESHOOTING. Malfunctions of the comparator can sometimes be traced to relatively simple causes such as a blown fuse, inoperative electron tubes, or poor connections. Check these possible trouble sources before making more detailed investigations. The most common malfunctions, probable causes, and recommended remedial action are listed in figure 1-8. Components are identified by their reference designation for easy reference to the schematic diagram (figure 1-4).

1-29. Use the voltage and resistance chart (figure 1-9) to isolate a malfunction to a stage of the comparator. All measurements should be made between the designated pin and ground, using an AN/PSM-6 multimeter. Voltage measurements should be taken only when the comparator is receiving, or is set to receive, the National Bureau of Standards transmission. Resistance checks must not be attempted before all power is removed from the comparator. When abnormal indications are encountered while performing voltage and resistance checks, check the appropriate components listed in figure 1-9, and replace them as necessary. No special disassembly procedures are necessary for removing any part from the comparator. If the power fuse blows more than once, make continuity checks to find the short circuit. Do not try to clear a short by burning it out; this can cause extensive damage to the comparator.

1-30. CALIBRATION.

1-31. The comparator must be calibrated upon receiving the unit, after the replacement of any major component, and at 1-year intervals thereafter.

1-32. To calibrate the comparator, follow the instructions in paragraphs 1-33 and 1-34, using the calibration equipment listed in figure 1-10, or the equivalent. Figures 1-12 and 1-13 show the location

TROUBLE	PROBABLE CAUSE	REMEDY
No video or audio; power indicator lamp glows.	RF amplifier V101; mixer V102 or V103; if. amplifier V104; local oscillator V112; buffer amplifier V113A; or rectifier V118 defective.	Check electron tubes. Perform voltage and resistance checks in accordance with figure 1-9. Replace components as necessary.
Five-megacycle beat not audible.	Mixer V103 defective.	
Fifteen-megacycle beat not audible.	Mixer V102 or V103 defective.	
No trace on cathode-ray tube.	Amplifier V110, cathode-ray tube V111, or rectifier V118 defective.	
Horizontal or vertical trace only on cathode-ray tube.	Phase shifter Z108 defective.	
No beat or intensity-modulation on cathode-ray tube.	Input amplifier V114; or frequency multiplier V115, V116, or V117 defective.	
Pin-point trace only on cathode-ray tube.	Frequency doubler V106 or V113B, mixer V109, or amplifier V110 defective.	
No tone or beat; trace normal.	Audio amplifier V108A defective.	
No tone; beat normal.	Detector V105B defective.	
Tone and beat at speaker, but not at jacks J107 and J108.	Audio amplifier V107 or V108A defective.	

Figure 1-8. Troubleshooting Chart

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
Optional	V101	1	-0.9	660K	C103, R101, R102, and S104
		2, 7	0	0	Wiring to ground
		5	210	80K	R104, R110, S104, Z102, Z103, and 250-volt supply
		6	98	80K	R103 and 108-volt supply
S104 at 15 MC	V102	1	92	78K	C111, R109, S104, and 108-volt supply
		2	0	22K	R107
		3, 6	1.0	82	R108
		7	0	0	Z102
		9	210	80K	R106, R110, S104, Z103, and 250-volt supply

Figure 1-9. Voltage and Resistance Chart (Sheet 1 of 5)

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
S104 at 15 MC (cont)	V108 (AUDIO VOLUME and TONE VOLUME controls set fully clockwise)	1	220	75K	T101 and 250-volt supply
		2	0	1M	R129
		3	3	330	R130
		6	220	75K	T102 and 250-volt supply
		7	0	2.5M	R140
		8	2.3	220	R141
	V109	1	105	80K	R156 and 108-volt supply
		2	-1.0	22K	R154
		3, 6	1.3	82	R155
		7	0	100K	R153 and Z106
		9	220	80K	R157, Z107, and 250-volt supply
	V110	1	0	0	Z107
		2	1.2	68	C171 and R158
		5	208	70K	R160, Z108, and 250-volt supply
		6	116	110K	R159 and 250-volt supply
		7	1.2	68	C172 and R158
	V112	1	-6.8	330K	R142
		2, 7	0.3	100	R143
		5	205	80K	R145, Z109, and 250-volt supply
		6	100	80K	R144 and 108-volt supply
	V113	1	190	80K	R149, Z110, and 250-volt supply
		2	-0.58	100K	R146
		3, 8	3.2	220	R147
		6	190	78K	R149, Z111, and 250-volt supply
		7	-37.5	100K	C153 and R148
S104 at 5 MC	V103	1	95	80K	R115 and 108-volt supply
		2	-3.5	22K	R113
		3, 6	1	82	C120, R114, and 250-volt supply

Figure 1-9. Voltage and Resistance Chart (Sheet 2 of 5)

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
S104 at 5 MC (cont)	V103 (cont)	7	-0.9	660K	R101, R111, R112, and Z103
		9	210	80K	R116, Z104, and 250-volt supply
	V104	1	-0.9	60K	R101, R117, R118, and Z104
		2, 7	0	0	Wiring to ground
		5	210	80K	R120, Z105, and 250-volt supply
		6	93	80K	R119 and 108-volt supply
	V105	1	38.5	220K	R121, R128, and 108-volt supply
		2	-0.14	28K	R122 and Z105
		5	0	0	Wiring to ground
		7	-0.9	660K	R101, R127, and Z105
	V106	1	-0.2	330K	C159 and R150
		2, 7	0	0	Wiring to ground
		5	230	80K	R152, Z106, and 250-volt supply
		6	38	200K	C160, R151, and 108-volt supply
	V107	1, 9	0.985	100	R134, R136, and R139
		2	-0.01	3M	R132, R133, and R138
		3	102	80K	C143, R135, and 108-volt supply
		6	240	75K	C142, Z115, and 250-volt supply
		7	6	3K	R134, R136, R139, and 250-volt supply
		8	0	1M	C142 and R138
	V114	1	-0.12	0-100K	R172
		2, 7	0.52	68	R173
		5	180	90K	R175 and 250-volt supply
		6	99	80K	C207, R174, and 108-volt supply
	V115	1	-0.35	1M	R162
		2, 7	0	0	Wiring to ground

Figure 1-9. Voltage and Resistance Chart (Sheet 3 of 5)

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
S104 at 5 MC (cont)	V115 (cont)	5	225	80K	R164, R165, Z112, and 250-volt supply
		6	68	220K	C181, R163, and 250-volt supply
	V116	1	-0.38	1M	R166
		2, 7	0	0	Wiring to ground
		5	235	80K	R168, Z113, and 250-volt supply
		6	65	220K	C189, R167, and 250-volt supply
	V117	1	-0.22	100K	R169
		2, 7	0	0	Wiring to ground
		5	235	80K	C197, R171, Z114, and 250-volt supply
		6	67	220K	C196, R170, and 250-volt supply
	V118	2, 8	295	70K	C205A, C205B, L102, R176, R117, R185, and T103
		4, 6	380(AC)	110	T103
	V119	1, 5	108	80K	R178, V119, and 250-volt supply
		2	0	0	Wiring to ground
		WARNING Do not measure voltage at pins of cathode-ray tube V111 without high-voltage probes.			
INTENSITY and FOCUS controls fully counter-clockwise	V111	1, 12	-840	3M	T103
		2	-900	3.4M	C203, C204, C176, CR102, CR103, R179, R180, R181, R182, R183, and T103
		3	-840	3M	T103

Figure 1-9. Voltage and Resistance Chart (Sheet 4 of 5)

CONTROL SETTING	TUBE	PIN NO.	VOLTS (DC)	RESISTANCE (OHMS)	IF INDICATION IS ABNORMAL, CHECK
INTENSITY and FOCUS controls fully counter-clockwise (cont)	V111 (cont)	4	-700	2.5M	C203, C204, CR102, CR103, R179, R180, R181, and T103
		6, 7, 8, 9, 10	230	80K	R160, Z108, and 250-volt supply

Figure 1-9. Voltage and Resistance Chart (Sheet 5 of 5)

NOMENCLATURE	PART NUMBER OR MODEL	APPLICATION	RANGE	ACCURACY
Signal generator	General Radio Model 1001-A	Variable frequency source	5 kc to 50 mc	±1 percent
Vacuum tube voltmeter	Ballantine Model 300G	Audio-frequency voltage measurements	1 mv to 1000 v	±2 percent
Vacuum tube voltmeter	Ballantine Model 317	Radio-frequency voltage measurements and counter preamplifier	1 mv to 300 v	±5 percent
Power divider	Microlab Model DB-3	Signal generator output junction	Not applicable	±1/2 db
Frequency counter	Hewlett-Packard Model 1001-A	Determine frequency output of signal generator	10 cps to 10.1 mc	5 parts in 10^8 stability/week
Audio oscillator	Hewlett-Packard Model 200CD	Variable audio-frequency source	5 cps to 600 kc	±2 percent
Attenuator	General Microwave Corp. Model D150	Vary signal-generator output level to comparator	0 to 41 db	±0.1 db/10 db
Attenuator	General Microwave Corp. Model D150-S1	Vary signal-generator output level to comparator	0 to 70 db	±0.1 db/10 db
50-ohm, 1/2-watt resistor (3 required)	Ohmite MIL Type RC-20	Resistive matching loads	Not applicable	±5 percent
600-ohm, 1/2-watt resistor	Ohmite MIL Type RC-20	Resistive matching load	Not applicable	±5 percent

Figure 1-10. Calibration Equipment

of the internal adjustments referenced in figure 1-11. After completing the calibration procedure, the comparator must be tested in accordance with the instructions in paragraphs 1-35 through 1-41 to check that the comparator is functioning correctly. Figures 1-14 and 1-15 show the setups used to test calibration accuracy.

1-33. PRELIMINARY PROCEDURE.

a. Set all controls to their off or fully counterclockwise position.

b. Connect comparator to a source of 115-volt, 60-cycle, single-phase power.

c. Set POWER switch to ON, and check that power indicator lamp glows. Allow 5 minutes for comparator to reach operating temperature.

1-34. CALIBRATION PROCEDURE. To calibrate the comparator, follow the procedure of figure 1-11. Connect the low side of the signal-generator output cable to chassis ground. Where the use of a vacuum tube voltmeter is indicated, connect the positive lead of Ballantine Model 300G to the specified point, and connect the negative lead to chassis ground.

1-35. CALIBRATION TESTS. The tests described in paragraphs 1-36 through 1-41 should be performed after calibration of the comparator, to determine whether it is functioning correctly. For all calibration tests, the comparator must be connected to a source of 115-volt, 60-cycle power, and the TONE VOLUME and AUDIO VOLUME controls must be set fully clockwise.

STEP	TO ALIGN	SIGNAL GENERATOR FREQUENCY AND OUTPUT LEVEL	INSERTION POINT	VACUUM TUBE VOLTMETER CONNECTION	PROCEDURE
1	Z107	10 mc, 1.0 v	XV109, pin 7	-----	Adjust primary and secondary of Z107 for maximum signal on cathode-ray tube.
2	Z108	10 mc, 1.0 v	XV109, pin 7	-----	Adjust primary of Z108 for maximum signal amplitude on cathode-ray tube. Adjust secondary of Z108, and C240, for circular pattern on cathode-ray tube.
3	Z109	-----	-----	XV113, pin 2	Set LOCAL OSC TRIMMER control C146 to midrange position. Rotate slug of Z109 counterclockwise until minimum voltage reading is obtained. Rotate slug clockwise to obtain 1.8-volt reading on vacuum tube voltmeter.
4	Z110	-----	-----	XV103, pin 2	Adjust Z110 for maximum voltage reading on vacuum tube voltmeter (approximately 16 volts).
5	Z111	-----	-----	XV109, pin 2	Adjust Z111 for maximum voltage reading on vacuum tube voltmeter (approximately 7 volts).
6	Z106	950 kc, 0.01 v	XV106, pin 1	-----	Adjust Z106 for maximum response on cathode-ray tube.

Figure 1-11. Calibration Procedures (Sheet 1 of 2)

STEP	TO ALIGN	SIGNAL GENERATOR FREQUENCY AND OUTPUT LEVEL	INSERTION POINT	VACUUM TUBE VOLTMETER CONNECTION	PROCEDURE
7	Z104 and Z105	5 mc, 1.0 mv	XV103, pin 7	-----	Adjust LOCAL OSC TRIMMER control for maximum response on cathode-ray tube. Adjust primary and secondary of Z105 and Z104 (in that order) for maximum response on cathode-ray tube.
8	Z102 and Z103	15 mc, 10 μ v	J101 (ANT INPUT)	-----	Set WWV SELECTOR switch S104 to 15 MC. Adjust primary and secondary of Z103 for maximum trace on cathode-ray tube. Adjust ANT TRIMMER control C103 as necessary. Reduce signal-generator input level as necessary. Adjust primary and secondary of Z102 for maximum signal on cathode-ray tube.
9	Z101	15 mc, 1 μ v	J101 (ANT INPUT)	-----	Set ANT TRIMMER control C103 to mid-range position. Adjust Z101 for maximum signal on cathode-ray tube.
10	C106	5 mc, 0.2 μ v	J101 (ANT INPUT)	-----	Set WWV SELECTOR switch S104 to 5 MC. Adjust C106 for maximum signal on cathode-ray tube.
11	Z112	400 kc, 1.0 v	J102 (LOCAL STANDARD INPUT)	J103 (400 KC OUTPUT)	Adjust Z112 for maximum reading on vacuum tube voltmeter (approximately 1 volt).
12	Z113	400 kc, 1.0 v	J102 (LOCAL STANDARD INPUT)	J104 (2 MC OUTPUT)	Adjust Z113 for maximum reading on vacuum tube voltmeter (approximately 0.3 volt).
13	Z114	400 kc, 1.0 v	J102 (LOCAL STANDARD INPUT)	J105 (10 MC OUTPUT)	Adjust Z114 for maximum reading on vacuum tube voltmeter (approximately 0.1 volt).

Figure 1-11. Calibration Procedures (Sheet 2 of 2)

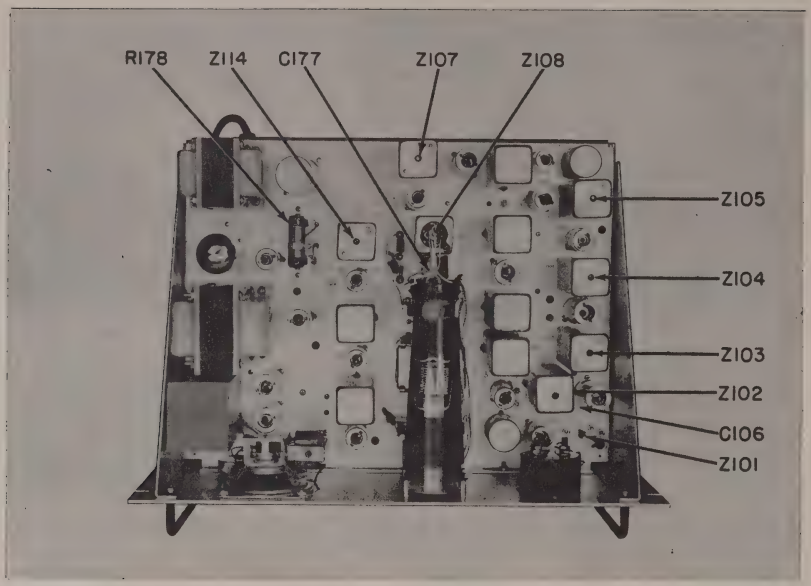


Figure 1-12. Location of Internal Adjustments, Top View

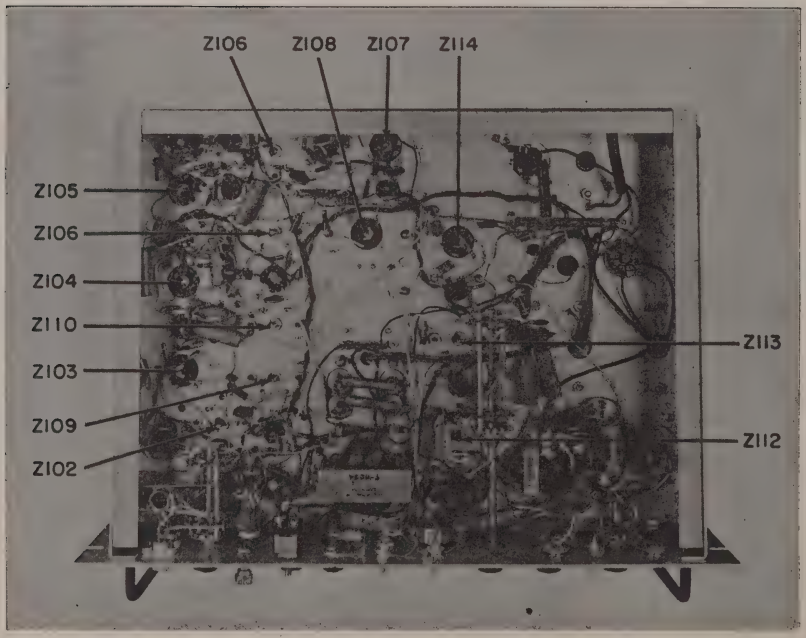


Figure 1-13. Location of Internal Adjustments, Bottom View

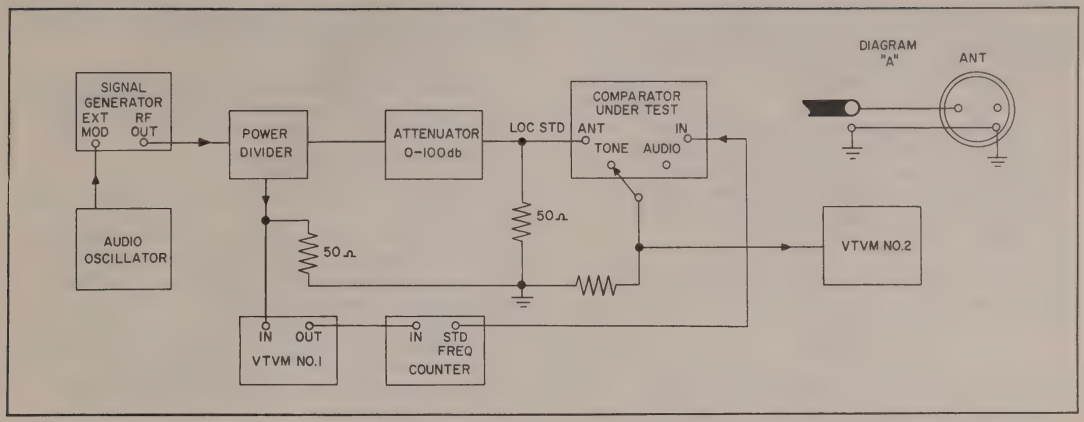


Figure 1-14. Calibration Setup No. 1

1-36. SENSITIVITY TEST. To perform the sensitivity test, connect the comparator and the calibration equipment as shown in figure 1-14; then, proceed as follows:

Note

During the sensitivity test, the signal generator output voltage level and frequency should be constantly monitored. Because the counter cannot operate directly from the signal generator output, the calibration setup shown in figure 1-14 uses vtvm No. 1 (Ballantine Model 317) as a voltmeter and as a preamplifier for the counter. Therefore, to measure voltage and frequency, the vtvm must be switched between its functions as a voltmeter and as a preamplifier.

a. Set WWV SELECTOR switch on comparator to 5 MC.

b. Adjust signal generator frequency to obtain a 5.0-megacycle reading on counter. Set signal generator for cw output.

c. Adjust signal generator output level to obtain a 10-millivolt reading on vtvm No. 1.

d. Set attenuator to 40 db.

e. Adjust ANT INPUT and LOCAL OSC TRIMMER controls on comparator for maximum reading on automatic gain control level meter and for a clear, noise-free trace on cathode-ray tube.

f. Increase setting of attenuator until trace on cathode-ray tube collapses. (ANT INPUT and LOCAL OSC TRIMMER controls should be adjusted to maintain maximum reading on automatic gain control level meter.) Check that attenuator setting is 80 db or greater. Record attenuator setting for reference during image rejection test.

g. Set WWV SELECTOR switch to 15 MC.

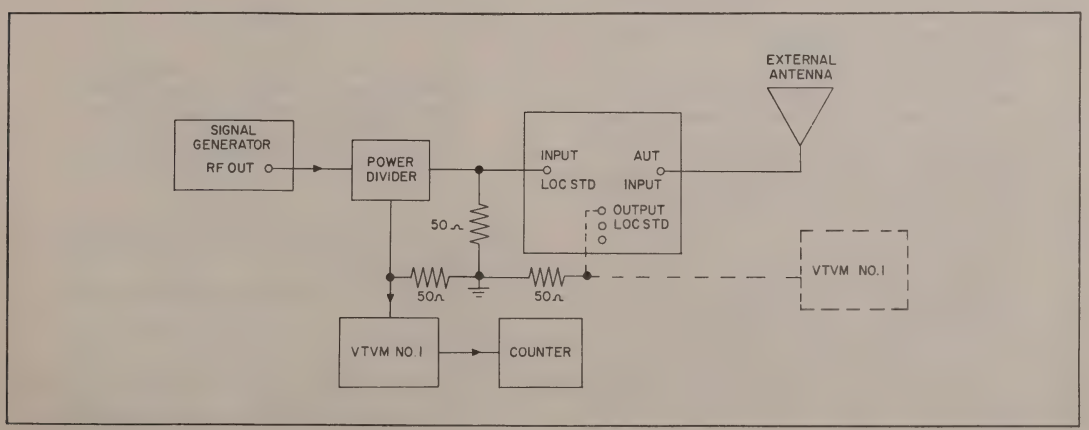


Figure 1-15. Calibration Setup No. 2

h. Adjust signal generator frequency to obtain a 15.0-megacycle reading on counter.

Note

To perform calibration tests at 15 megacycles, a stable 10-megacycle signal must be injected into the LOCAL STANDARD INPUT connector on the comparator. This signal is derived from the counter, as shown in figure 1-14.

i. Adjust signal generator output level to obtain a 10-millivolt reading on vtvm No. 1.

Note

Because vtvm No. 1 exhibits a significant error at 15 megacycles, the voltmeter should have a correction factor for measuring at this frequency. As an alternative, the signal generator output meter can be used with the signal output level set to 0.02 volt.

j. Repeat steps d., e., and f.

1-37. AUTOMATIC GAIN CONTROL TEST. To perform the automatic gain control test, disconnect the lead from the counter to the LOCAL STANDARD INPUT connector, and proceed as follows:

a. Repeat steps a. through e., paragraph 1-36.

b. Reduce attenuator setting to 0 db while observing automatic gain control level meter and trace on cathode-ray tube. Check that reading on meter increases as attenuator setting is decreased and that trace remains on cathode-ray tube for all signal levels between 40 and 0 db.

1-38. IMAGE-REJECTION TEST. To perform the image-rejection test, refer to Note preceding step a., paragraph 1-36, and proceed as follows:

a. Adjust signal generator frequency to approximately 4.050 megacycles (with WWV SELECTOR switch set to 5 MC).

b. Adjust signal generator output level to obtain a 10-millivolt reading on vtvm No. 1.

c. Set attenuator to 0 db.

d. Search for exact image frequency (which is a function of comparator oscillator frequency) by very slowly varying signal generator frequency until maximum response is obtained on comparator.

e. Increase attenuator setting until trace on cathode-ray tube collapses. Check that attenuator setting is at least 70 db less than setting obtained in step f., paragraph 1-36.

f. Set WWV SELECTOR switch to 15 MC.

g. Adjust signal generator frequency to approximately 5 megacycles, and repeat steps c., d., and e. (See Note following step l., paragraph 1-36.)

h. Increase attenuator setting until trace on cathode-ray tube collapses. Check that attenuator setting is at least 70 db less than setting obtained in step j., paragraph 1-36.

1-39. AUDIO VOLTAGE TEST. To perform the audio voltage test, disconnect the lead from the counter to the LOCAL STANDARD INPUT connector, and proceed as follows:

a. Set WWV SELECTOR switch to 5 MC.

b. Adjust signal generator frequency to obtain a 5.0-megacycle reading on counter.

c. Adjust signal generator output level to obtain a 10-millivolt reading on vtvm No. 1.

d. Set attenuator to 20 db.

e. Connect 600-ohm load to AUDIO OUTPUT jack on comparator.

f. Set signal generator for amplitude-modulated output, and adjust modulation level to 50 percent.

g. Set audio oscillator to 440 cycles, and check that voltage indicated on vtvm No. 2 (Ballantine Model 300G) is less than 10 volts.

h. Disconnect 600-ohm load from AUDIO OUTPUT jack, and connect it to TONE OUTPUT jack.

i. Set TONE SELECTOR switch to 440 cycles, and check that voltage indicated on vtvm No. 2 is less than 10 volts.

j. Set audio oscillator to 600 cycles.

k. Set TONE SELECTOR switch to 600 cycles, and check that voltage indicated on vtvm No. 2 is less than 10 volts.

l. Set audio oscillator to 1000 cycles.

m. Set TONE SELECTOR switch to 1000 cycles, and check that voltage indicated on vtvm No. 2 is less than 10 volts.

n. Disconnect setup shown in figure 1-14.

1-40. LOCAL-STANDARD INPUT TEST. To perform the local-standard input test, connect the comparator and the calibration equipment as shown in figure 1-15, and proceed as follows:

a. Set WWV SELECTOR switch to 5 MC.

b. Rotate LOCAL STANDARD INPUT LEVEL control on comparator fully clockwise.

c. Set LOCAL STANDARD INPUT RANGE-MC switch to .05-.4.

d. Adjust output frequency of signal generator to 400 kilocycles, and adjust output level to obtain a 0.1-volt reading on vtvm.

Note

The cathode-ray tube of the comparator should display a blanking pattern corresponding to the error in the local standard. Adjust the signal generator frequency to obtain a stationary or slowly rotating pattern on the cathode-ray tube.

e. Connect vtvm to 400 KC OUTPUT connector on comparator, and check that indicated voltage is 0.1 volt or greater.

f. Set LOCAL STANDARD INPUT RANGE-MC switch to .5-2.

g. Repeat step d., with signal generator set to 2.0 megacycles.

h. Connect vtvm to 2 MC OUTPUT connector, and check that indicated voltage is 0.1 volt or greater.

i. Set LOCAL STANDARD INPUT RANGE-MC switch to 2.5-10.

j. Repeat step d., with signal generator set to 10.0 megacycles.

k. Connect vtvm to 10 MC OUTPUT connector, and check that indicated voltage is 0.1 volt or greater.

l. Disconnect setup shown in figure 1-15, but leave antenna connected.

1-41. Check tone, time ticks, voice announcements, and Morse code for 10 minutes to be sure that they are clearly audible. If performance is satisfactory, it can be assumed that the comparator is properly calibrated.

SECTION II

PARTS BREAKDOWN

2-1. INTRODUCTION.

2-2. This Parts Breakdown provides necessary data for the location and identification of all replaceable parts and components used in the WWV Frequency Comparator, Model 550. Typical sources are shown for standard electrical, electronic, and hardware items. Substitution of equivalent parts can be made in accordance with standard practice. If parts are identified with a part number, and no vendor code appears in the description column, these items are manufactured by General Microwave Corporation. If a vendor code appears in the description column, refer to the following list of vendor codes for the applicable name and address of the vendor from whom the part can be procured, under the part number listed. Items listed with "COMM" in the part number column are standard commercial components which may be procured from any available source, under the description shown for each item.

2-3. VENDORS' CODES.

2-4. Each part supplied by a vendor is identified in the description column with the applicable 5-digit Federal Manufacturers' Code. The names and addresses of these vendors are as follows:

VENDORS' CODE

CODE	NAME AND ADDRESS
06540	Amatom Electronic Hardware Co, Inc New Rochelle, NY
08289	Blinn Delbert Co Pamona, Calif
11332	General Microwave Corp Farmingdale, NY
11443	General Electric Co Receiving Tube Department of Electronic Components Division Anniston, Ala
12697	Clarostat Mfg Co, Inc Dover, NH
14655	Cornell-Dubilier Electric Corp South Plainfield, NJ
28520	Heyman Manufacturing Co Kenilworth, NJ

VENDORS' CODE (Cont)

CODE	NAME AND ADDRESS
44655	Ohmite Manufacturing Co Skokie, Ill
49675	Radio Corporation of America, Industrial Electronic Products Div Camden, NJ
57771	Edwin B. Stimpson Co, Inc Brooklyn, NY
71590	Centralab Div of Globe Union, Inc Milwaukee, Wis
71785	Cinch Mfg Corp Chicago, Ill
72765	Drake Mfg Co Chicago, Ill
72825	Hugh H. Eby, Inc Philadelphia, Pa
72982	Erie Resistor Corp Erie, Pa
73506	Bradley Semiconductor Corp New Haven, Conn
73559	Carling Electric, Inc Hartford, Conn
73899	JFD Electronics Corp Brooklyn, NY
74970	E. F. Johnson Co Waseca, Minn
75376	Kurz-Kasch, Inc Chicago, Ill
75378	The James Knights Co, Inc Sandwich, Ill
75915	Littelfuse, Inc Des Plaines, Ill
78189	Shakeproof Div of Illinois Tool Works Elgin, Ill
78553	Tinnerman Products, Inc Cleveland, Ohio

VENDORS' CODE (Cont)

CODE	NAME AND ADDRESS
79963	Zierick Manufacturing Corp New Rochelle, NY
80035	Winchester Electronics Co, Inc New York, NY
80183	Sprague Products Co North Adams, Mass
80331	Utah Radio Products Corp Huntington, Ind
81875	Rohden Manufacturing Co Chicago, Ill
82219	Sylvania Electric Products, Inc Electronic Tube Div, Receiving Tube Operations Emporium, Pa

VENDORS' CODE (Cont)

CODE	NAME AND ADDRESS
82389	Switchcraft, Inc Chicago, Ill
90816	Phalo Plastics Corp Worcester, Mass
94154	Tung-Sol Electric, Inc Newark, NJ
97966	CBS Hytron Div of Columbia Broadcasting Systems, Inc Danvers, Mass
99813	Jan Hardware Mfg Co, Inc Brooklyn, NY

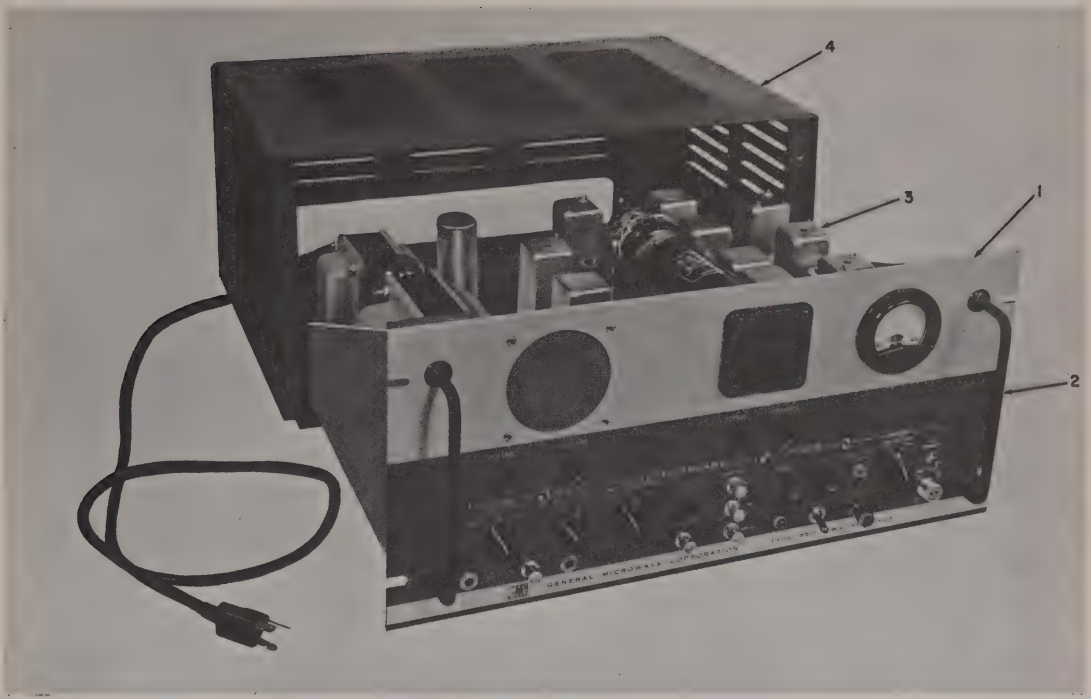


Figure 2-1. WWV Frequency Comparator, Model 550

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE
2-1	1418	COMPARATOR, WWV FREQUENCY, Model 550 . . .	1	
	No Number	. COMPARATOR SUB-ASSEMBLY	1	
		(ATTACHING PARTS)		
	COMM	. SCREW, MACHINE, OVAL HEAD, SLOTTED, . .	4	
		10-32 by 1/2 in. lg, steel, nickel plated		
	CS211-88	. SCREW, MACHINE, PAN HEAD, CROSS-	2	
		RECESSED		
	C119	. WASHER, CUP, No. 10 screw, brass, nickel . .	4	
		plated (57771)		
	NW15-10	. WASHER, NYLON, No. 10 screw, 0.576 OD . . .	4	
		by 0.415 ID by 0.105 in. thick (08289)		
		---*---		
-1	No Number	. . PANEL ASSEMBLY (See Figure 2-2 for	1	
		breakdown)		
-2	5441	. . HANDLE (06540)	2	
		(ATTACHING PARTS)		
	CS211-116	. . SCREW, MACHINE, PAN HEAD, CROSS- . . .	3	
		RECESSED (for item 1)		
	CS210-118	. . SCREW, MACHINE, PAN HEAD, SLOTTED . .	4	
		(for items 1 and 2)		
	4436	. . FERRULE, HANDLE (06540) (for items 1 . . .	4	
		and 2)		
		---*---		
-3	No Number	. . CHASSIS ASSEMBLY (See Figure 2-3 for . . .	1	
		breakdown)		
-4	1431	. CABINET, 8-3/4 by 19 in. nominal panel.	1	
	R1650-B	. . BUTTON, Rest (81875)	4	

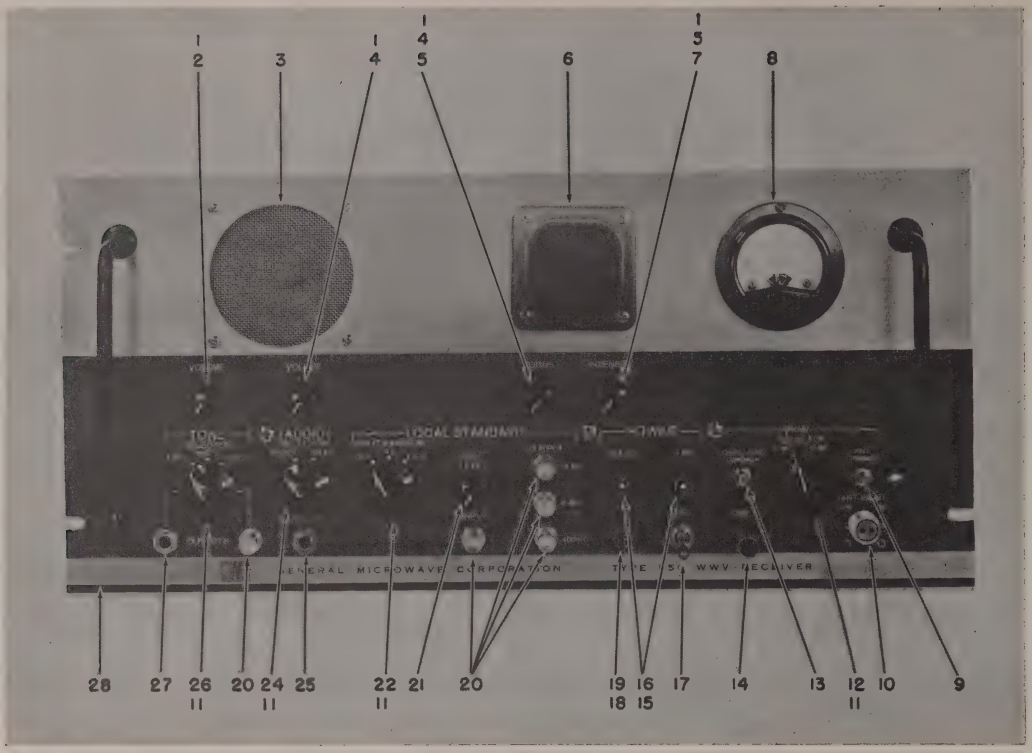


Figure 2-2. Panel Assembly

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-2	No Number	PANEL ASSEMBLY (See item 1, figure 2-1, for next higher assembly)	Ref	
-1	S-645-3L-BB	. KNOB, Round, black phenolic, with set screws (75376)	5	
-2	53	. POTENTIOMETER, 2.5 megohms ±20%, 2 W. 3/8 lg bushing, 1/4 dia shaft 5/8 lg from mounting surface (supplied with mounting hardware) (12697)	1	
-3	1548	. SCREEN, Speaker, 20-mesh standard aluminum. wire cloth, clear anodize, 3.44 in. by 3.44 in.	1	
-4	53	. POTENTIOMETER, 1 megohm ±20%, 2 W, 3/8 lg bushing, 1/4 dia shaft 5/8 lg from mounting surface (supplied with mounting hardware) (12697)	2	
-5	AK-5164-B-1	. COUPLING, HIGH VOLTAGE (supplied with mounting hardware) (99813)	2	
-6	CP-1110P-2	. BEZEL ASSEMBLY, Cathode-ray tube shield (99813)	1	
		(ATTACHING PARTS)		
	COMM	. SCREW, MACHINE, OVAL HEAD, CROSS-RECESSED, 6-32 by 1-1/4 in. lg, steel, black nickel plated	4	
	4167	. SPACER (06540)	4	
		---*---		

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-2-7	53	POTENTIOMETER, 250K ohm ± 20%, 2 W, 3/8 lg bushing, 1/4 dia shaft 5/8 lg from mounting surface (supplied with mounting hardware) (12697)	1	
-8	1557	VOLTMETER, 0 to 15 volts dc (supplied with mounting hardware)	1	
-9	160-104	TRIMMER, VARIABLE, 1.8 to 8.7 uuf, 1250 vdcw (supplied with mounting hardware) (74970)	1	
-10	UG-103/U	CONNECTOR, RECEPTACLE, ELECTRICAL (ATTACHING PARTS)	1	
	CS211-46	SCREW, MACHINE, PAN HEAD, CROSS-RECESSED	4	
	CS270-1	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	4	
		---*---		
-11	S-657-3L-BB	KNOB, Pointer, black phenolic, with set screws (75376)	4	
-12	1546	SWITCH, ROTARY, 2-position (supplied with mounting hardware)	1	
-13	160-110	TRIMMER, VARIABLE, 2.7 to 19.6 uuf, 1250 vdcw (supplied with mounting hardware) (74970)	1	
-14	6639	POST, BINDING (72825) (ATTACHING PARTS)	1	
	CS270-3	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	1	
		---*---		
-15	COMM	FUSE, CARTRIDGE, 3AG, 2 ampere	2	
-16	342004	FUSEHOLDER (supplied with mounting hardware) (75915)	2	
-17	2GK63-62	SWITCH, TOGGLE, DPST (supplied with mounting hardware) (73559)	1	
-18	5B	LAMPHOLDER, with red jewel (supplied with mounting hardware) (72765)	1	
-19	COMM	LAMP, MINIATURE, BAYONET BASE, Type 51	1	
-20	UG-1094/U	CONNECTOR, RECEPTACLE, ELECTRICAL (supplied with mounting hardware)	5	
-21	53	POTENTIOMETER, 100K ohms ±20%, 2 W, 3/8 lg bushing, 1/4 dia shaft 5/8 lg from mounting surface (supplied with mounting hardware) (12697)	1	
-22	1545	SWITCH, ROTARY, 3-position (supplied with mounting hardware)	1	
-23	512	PANEL BEARING (06540)	1	
-24	1544	SWITCH, ROTARY, 2-position (supplied with mounting hardware)	1	
-25	12A	JACK (supplied with mounting hardware (82389)	1	
-26	1547	SWITCH, ROTARY, 3-position (supplied with mounting hardware)	1	
-27	11	JACK (supplied with mounting hardware) (82389)	1	
-28	1421	PANEL	1	

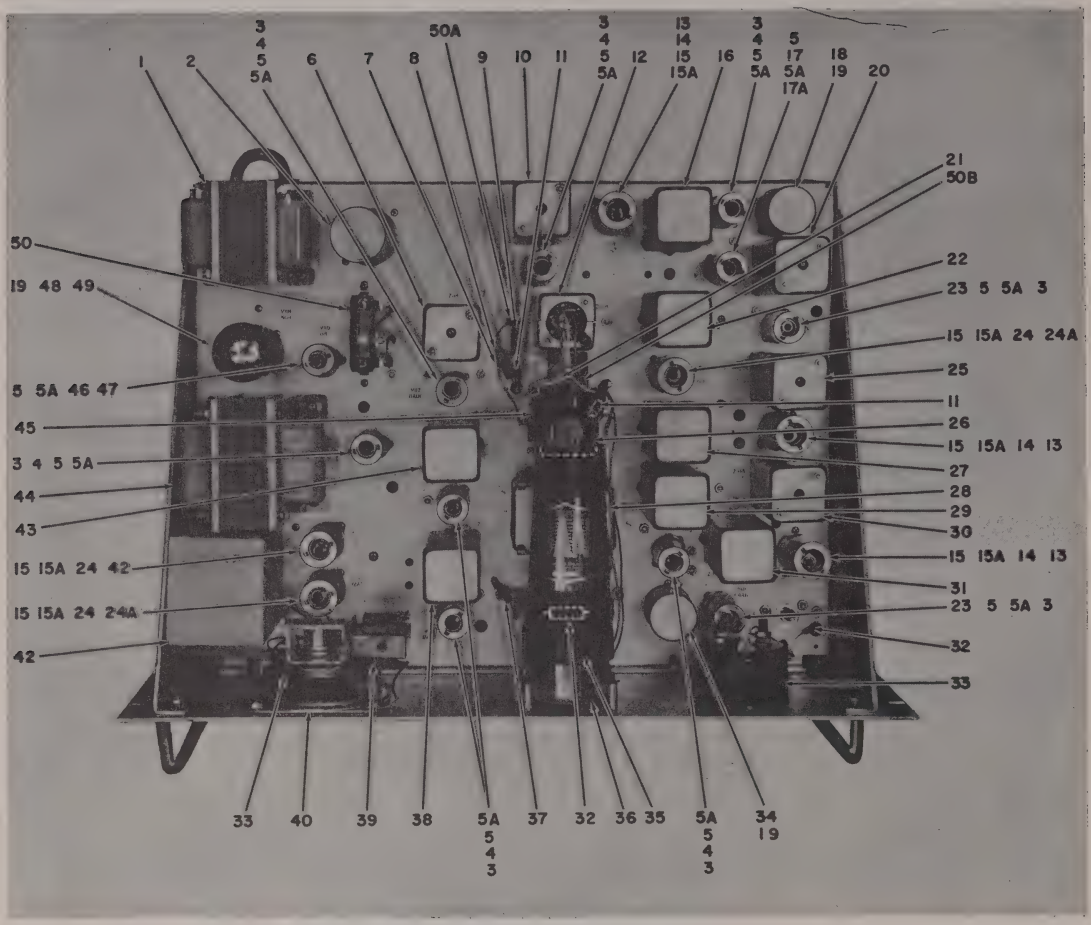


Figure 2-3. Chassis Assembly (Sheet 1 of 2)

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE
2-3	No Number	CHASSIS ASSEMBLY (See item 3, figure 2-1, for next higher assembly)	Ref	
-1	1503	. CHOKE (ATTACHING PARTS)	1	
	CS210-88	. SCREW, MACHINE, PAN HEAD, SLOTTED	4	
	CS270-3	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER ---*	4	
-2	Type UP	. CAPACITOR, FIXED, ELECTROLYTIC, Twist prong base, 80-40 uf/450 volt, 1-3/8 dia can with metal mounting plate (14655) (ATTACHING PARTS)	1	
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER ---*---	2	

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-3	8661	. SHIELD, ELECTRON TUBE (71785)	9	
-4	6AU6	. ELECTRON TUBE, Pentode (82219)	7	
-5	9727-11	. SOCKET, ELECTRON TUBE, 7-contact (72825) .	11	
-5A	1050	. SHIELD BASE, Miniature (71785)	11	
		(ATTACHING PARTS)		
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED . . .	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-6	1598	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-7	CD15E331J300	. CAPACITOR, FIXED, MICA, 330 uuf ± 5%, 300 .	1	
		vdcw (14655)		
-8	COMM	. DIODE, Type 1N34A	1	
-9	CD15C020K	. CAPACITOR, FIXED, MICA, 2 uuf ± 10%, 500 . .	1	
		vdcw (14655)		
-10	1591	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-11	COMM	. RESISTOR, FIXED, COMPOSITION, 100K ± 10% .	2	
		1/2 W		
-12	1592	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-13	13B12628	. SHIELD, ELECTRON TUBE, NOVAL (71785) . . .	3	
-14	6BA7	. ELECTRON TUBE, Pentagrid converter (11443) .	3	
-15	9713-24	. SOCKET, ELECTRON TUBE, NOVAL, 9-contact .	6	
		(72825)		
-15A	20K13979	. SHIELD BASE, NOVAL (71785)	6	
		(ATTACHING PARTS)		
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED . . .	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-16	1590	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-17	8660	. SHIELD, ELECTRON TUBE (71785)	1	
-17A	6AL5	. ELECTRON TUBE, Twin diode (82219).	1	
-18	JK09S1	. OVEN AND CRYSTAL UNIT, Frequency 475 kc . .	1	
		(75378)		
-19	CS402	. SOCKET, TUBE, Octal	3	
		(ATTACHING PARTS)		
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED . . .	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		
-20	1589	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH	2	
		LOCKWASHER		
		---*---		

FIG. & INDEX NO.	PART NO.	DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-21	503-000, NPO	CAPACITOR, VARIABLE, CERAMIC, 1.5 to 7 uuf, 500 vdcw (72982)	1	
		(ATTACHING PARTS)		
	CS210-48	SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	COMM	WASHER, FIBER, No. 4 bolt	2	
	CS270-1	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-22	1595	NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-23	6BA6	ELECTRON TUBE, Pentode (82219)	2	
-24	13B12627	SHIELD, ELECTRON TUBE, NOVAL (71785)	3	
-24A	12AT7	ELECTRON TUBE, High-mu twin triode (94154)	2	
-25	1588	NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-1	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-26	4-53010	CAPACITOR, FIXED, MICA, 100 uuf ±10%, 2500 vdcw, 1-5/16 mounting hole spacing (14655)	1	
		(ATTACHING PARTS)		
	CS210-612	SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	CS270-2	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-27	1594	NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-28	TJH150025	CAPACITOR, FIXED, PAPER DIELECTRIC, 0.25 uf ±20%, 1500 vdcw, (supplied with spade-lug mounting brackets) (14655)	2	
		(ATTACHING PARTS)		
	CS270-4	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-29	1593	NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-30	1510	NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-1	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-31	1509	NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-32	COMM	RESISTOR, FIXED, COMPOSITION, 560K ±10%, 1/2 W	2	
-33	CG	CAPACITOR, CERAMIC DISC, 0.01 uf, GMV, 500 vdcw (71590)	2	
-34	JK09S1	OVEN AND CRYSTAL UNIT, Frequency 4525 kc (75378)	1	

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-35	S2001-1	. SHIELD, Cathode-ray tube (99813)	1	
-36	2BP1	. TUBE, Cathode-ray (49675)	1	
-37	COMM	. RESISTOR, FIXED, COMPOSITION, 1.5 meg, ± 10%, 1 W	1	
-38	1596	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-39	1505	. TRANSFORMER, Output	1	
		(ATTACHING PARTS)		
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-40	SP35A	. LOUDSPEAKER (80331)	1	
		(ATTACHING PARTS)		
	CS211-66	. SCREW, MACHINE, PAN HEAD, CROSS- RECESSED	4	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	4	
		---*---		
-41	1537	. FILTER, Audio	1	
		(ATTACHING PARTS)		
	CS210-66	. SCREW, MACHINE, PAN HEAD, SLOTTED	4	
	1106-00	. LOCKWASHER, EXTERNAL TOOTH (78189)	4	
		---*---		
-42	6AM8	. ELECTRON TUBE, Diode-pentode (82219)	1	
-43	1597	. NETWORK ASSEMBLY	1	
		(ATTACHING PARTS)		
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-44	1504	. TRANSFORMER, Power	1	
		(ATTACHING PARTS)		
	CS210-88	. SCREW, MACHINE, PAN HEAD, CROSS- RECESSED	4	
	CS270-3	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	4	
		---*---		
-45	9464-12	. SOCKET, TUBE, Duodecal (71785)	1	
-46	13A12564	. SHIELD, ELECTRON TUBE (71785)	1	
-47	OB2	. ELECTRON TUBE, Voltage regulator (97966)	1	
-48	5U4GB	. ELECTRON TUBE, Rectifier (97966)	1	
-49	16169	. HOLDER, TUBE (71785)	1	
-50	0379	. RESISTOR, ADJUSTABLE, Wirewound, 3K, ± 10%, 25 W (supplied with mounting brackets) (44655)	1	
		(ATTACHING PARTS)		
	CS210-66	. SCREW, MACHINE, PAN HEAD, SLOTTED	2	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH LOCKWASHER	2	
		---*---		
-50A	1513-A	. TERMINAL STRIP, 2-lug (71785)	3	
-50B	1442	. SHIELD, CAPACITOR	1	
-51	1446	. BRACKET, SWITCH	1	
-52	SB-375-4	. BUSHING, SNAP (28520)	4	
-53	1508	. COIL, Single-tuned (supplied with mounting hardware)	1	
-54	31811	. CABLE, 3-conductor, 0.330 in. nominal OD by 6 ft lg (90816)	1	
	MS24663	. CONNECTOR, PLUG, ELECTRICAL	1	
	SR-6P-1	. STRAIN RELIEF (28520)	1	

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-55	CG	CAPACITOR, CERAMIC DISC, 0.01 uf, GMV. . . 500 vdcw (71590)	37	
-56	CG	CAPACITOR, CERAMIC DISC, 1000 uuf, GMV, . . 500 vdcw (71590)	10	
-57	CG	CAPACITOR, CERAMIC DISC, 0.02 uf, GMV, . . 500 vdcw (71590)	1	
-58	BYD6DS1	CAPACITOR, CERAMIC DISC, 2-section, 0.01 . . uf, GMV, 600 vdcw each section (14655)	8	
-59	CD15C220J300	CAPACITOR, SILVER MICA, 22 uuf ±5%, 300 . . vdcw (14655)	1	
-60	CD15E101J300	CAPACITOR, SILVER MICA, 100 uuf ±5%, 300 . . vdcw (14655)	3	
-61	CD15E331J300	CAPACITOR, SILVER MICA, 330 uuf ± 5%, 300 . vdcw (14655)	2	
-62	CD15C050K	CAPACITOR, SILVER MICA, 5 uuf ±10%, 500 . . vdcw (14655)	1	
-63	CD15C020K	CAPACITOR, SILVER MICA, 2 uuf ±10%, 500 . . vdcw (14655)	1	
-64	CD15C100K300	CAPACITOR, SILVER MICA, 10 uuf ±10%, 300 . . vdcw (14655)	2	
-65	BBR100-15	CAPACITOR, ELECTROLYTIC, 100 uf, 15. . . . vdcw (14655)	1	
-66	160P10494	CAPACITOR, PAPER, 0.1 uf ± 10%, 400 vdcw . . (80183)	8	
-67	VC-11G	CAPACITOR, VARIABLE, GLASS, 0.7 to 12 . . . uuf, 1K vdcw (73899)	1	
-68	FT9	FEED-THRU (80035)	2	
-69	334	LUG, SOLDER, with 0.375 in. dia hole (79963) . .	3	
-70	SE3L30H	RECTIFIER, METALLIC, 780V AC input, 1.5 . . MA DC output (73506)	2	
-71	COMM	RESISTOR, FIXED, COMPOSITION, 560K ±10%, . 1/2 W	1	
-72	COMM	RESISTOR, FIXED, COMPOSITION, 100K ±10%, . 1/2 W	8	
-73	COMM	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, . 1/2 W	12	
-74	COMM	RESISTOR, FIXED, COMPOSITION, 1 meg, . . . ±10%, 1/2 W	5	
-75	COMM	RESISTOR, FIXED, COMPOSITION, 10 ohms . . ±10%, 1/2 W	2	
-76	COMM	RESISTOR, FIXED, COMPOSITION, 22K ±10%, . 1/2 W	3	
-77	COMM	RESISTOR, FIXED, COMPOSITION, 82 ohms . . ±10%, 1/2 W	2	
-78	COMM	RESISTOR, FIXED, COMPOSITION, 1K ±10%, . . 1/2 W	4	
-79	COMM	RESISTOR, FIXED, COMPOSITION, 470K ±10%, . 1/2 W	1	
-80	COMM	RESISTOR, FIXED, COMPOSITION, 330K ±10%, . 1/2 W	3	
-81	COMM	RESISTOR, FIXED, COMPOSITION, 27K ±10%, . 1/2 W	1	
-82	COMM	RESISTOR, FIXED, COMPOSITION, 6.8K ±10%, . 1/2 W	3	
-83	COMM	RESISTOR, FIXED, COMPOSITION, 330 ohms . . ±5%, 1/2 W	1	
-84	COMM	RESISTOR, FIXED, COMPOSITION, 2.2 meg. . . ±10%, 1/2 W	1	
-85	COMM	RESISTOR, FIXED, COMPOSITION, 2.7K ±5%, . 1/2 W	1	
-86	COMM	RESISTOR, FIXED, COMPOSITION, 3.3K ±5%, . 1 W	3	

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE
2-3-55	CG	. CAPACITOR, CERAMIC DISC, 0.01 uf, GMV. . . 500 vdcw (71590)	37	
-56	CG	. CAPACITOR, CERAMIC DISC, 1000 uuf, GMV, . . 500 vdcw (71590)	10	
-57	CG	. CAPACITOR, CERAMIC DISC, 0.02 uf, GMV, . . 500 vdcw (71590)	1	
-58	BYD6DS1	. CAPACITOR, CERAMIC DISC, 2-section, 0.01 . . uf, GMV, 600 vdcw each section (14655)	8	
-59	CD15C220J300	. CAPACITOR, SILVER MICA, 22 uuf ±5%, 300 . . vdcw (14655)	1	
-60	CD15E101J300	. CAPACITOR, SILVER MICA, 100 uuf ±5%, 300 . . vdcw (14655)	3	
-61	CD15E331J300	. CAPACITOR, SILVER MICA, 330 uuf ± 5%, 300 . vdcw (14655)	2	
-62	CD15C050K	. CAPACITOR, SILVER MICA, 5 uuf ±10%, 500 . . vdcw (14655)	1	
-63	CD15C020K	. CAPACITOR, SILVER MICA, 2 uuf ±10%, 500 . . vdcw (14655)	1	
-64	CD15C100K300	. CAPACITOR, SILVER MICA, 10 uuf ±10%, 300 . . vdcw (14655)	2	
-65	BBR100-15	. CAPACITOR, ELECTROLYTIC, 100 uf, 15. . . . vdcw (14655)	1	
-66	160P10494	. CAPACITOR, PAPER, 0.1 uf ± 10%, 400 vdcw . . (80183)	8	
-67	VC-11G	. CAPACITOR, VARIABLE, GLASS, 0.7 to 12 . . . uuf, 1K vdcw (73899)	1	
-68	FT9	. FEED-THRU (80035)	2	
-69	334	. LUG, SOLDER, with 0.375 in. dia hole (79963) . .	3	
-70	SE3L30H	. RECTIFIER, METALLIC, 780V AC input, 1.5 . . MA DC output (73506)	2	
-71	COMM	. RESISTOR, FIXED, COMPOSITION, 560K ±10%, . 1/2 W	1	
-72	COMM	. RESISTOR, FIXED, COMPOSITION, 100K ±10%, . 1/2 W	8	
-73	COMM	. RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, . 1/2 W	12	
-74	COMM	. RESISTOR, FIXED, COMPOSITION, 1 meg, . . . ±10%, 1/2 W	5	
-75	COMM	. RESISTOR, FIXED, COMPOSITION, 10 ohms . . ±10%, 1/2 W	2	
-76	COMM	. RESISTOR, FIXED, COMPOSITION, 22K ±10%, . 1/2 W	3	
-77	COMM	. RESISTOR, FIXED, COMPOSITION, 82 ohms . . ±10%, 1/2 W	2	
-78	COMM	. RESISTOR, FIXED, COMPOSITION, 1K ±10%, . . 1/2 W	4	
-79	COMM	. RESISTOR, FIXED, COMPOSITION, 470K ±10%, . 1/2 W	1	
-80	COMM	. RESISTOR, FIXED, COMPOSITION, 330K ±10%, . 1/2 W	3	
-81	COMM	. RESISTOR, FIXED, COMPOSITION, 27K ±10%, . 1/2 W	1	
-82	COMM	. RESISTOR, FIXED, COMPOSITION, 6.8K ±10%, . 1/2 W	3	
-83	COMM	. RESISTOR, FIXED, COMPOSITION, 330 ohms . . ±5%, 1/2 W	1	
-84	COMM	. RESISTOR, FIXED, COMPOSITION, 2.2 meg. . . ±10%, 1/2 W	1	
-85	COMM	. RESISTOR, FIXED, COMPOSITION, 2.7K ±5%, . 1/2 W	1	
-86	COMM	. RESISTOR, FIXED, COMPOSITION, 3.3K ±5%, . 1 W	3	

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-55	CG	. CAPACITOR, CERAMIC DISC, 0.01 uf, GMV. . . 500 vdcw (71590)	37	
-56	CG	. CAPACITOR, CERAMIC DISC, 1000 uuf, GMV, . . 500 vdcw (71590)	10	
-57	CG	. CAPACITOR, CERAMIC DISC, 0.02 uf, GMV, . . 500 vdcw (71590)	1	
-58	BYD6DS1	. CAPACITOR, CERAMIC DISC, 2-section, 0.01 . . uf, GMV, 600 vdcw each section (14655)	8	
-59	CD15C220J300	. CAPACITOR, SILVER MICA, 22 uuf ±5%, 300 . . vdcw (14655)	1	
-60	CD15E101J300	. CAPACITOR, SILVER MICA, 100 uuf ±5%, 300 . . vdcw (14655)	3	
-61	CD15E331J300	. CAPACITOR, SILVER MICA, 330 uuf ± 5%, 300 . vdcw (14655)	2	
-62	CD15C050K	. CAPACITOR, SILVER MICA, 5 uuf ±10%, 500 . . vdcw (14655)	1	
-63	CD15C020K	. CAPACITOR, SILVER MICA, 2 uuf ±10%, 500 . . vdcw (14655)	1	
-64	CD15C100K300	. CAPACITOR, SILVER MICA, 10 uuf ±10%, 300 . . vdcw (14655)	2	
-65	BBR100-15	. CAPACITOR, ELECTROLYTIC, 100 uf, 15. . . . vdcw (14655)	1	
-66	160P10494	. CAPACITOR, PAPER, 0.1 uf ± 10%, 400 vdcw . . (80183)	8	
-67	VC-11G	. CAPACITOR, VARIABLE, GLASS, 0.7 to 12 . . . uuf, 1K vdcw (73899)	1	
-68	FT9	. FEED-THRU (80035)	2	
-69	334	. LUG, SOLDER, with 0.375 in. dia hole (79963) . .	3	
-70	SE3L30H	. RECTIFIER, METALLIC, 780V AC input, 1.5 . . MA DC output (73506)	2	
-71	COMM	. RESISTOR, FIXED, COMPOSITION, 560K ±10%, . 1/2 W	1	
-72	COMM	. RESISTOR, FIXED, COMPOSITION, 100K ±10%, . 1/2 W	8	
-73	COMM	. RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, . 1/2 W	12	
-74	COMM	. RESISTOR, FIXED, COMPOSITION, 1 meg, . . . ±10%, 1/2 W	5	
-75	COMM	. RESISTOR, FIXED, COMPOSITION, 10 ohms . . ±10%, 1/2 W	2	
-76	COMM	. RESISTOR, FIXED, COMPOSITION, 22K ±10%, . 1/2 W	3	
-77	COMM	. RESISTOR, FIXED, COMPOSITION, 82 ohms . . ±10%, 1/2 W	2	
-78	COMM	. RESISTOR, FIXED, COMPOSITION, 1K ±10%, . . 1/2 W	4	
-79	COMM	. RESISTOR, FIXED, COMPOSITION, 470K ±10%, . 1/2 W	1	
-80	COMM	. RESISTOR, FIXED, COMPOSITION, 330K ±10%, . 1/2 W	3	
-81	COMM	. RESISTOR, FIXED, COMPOSITION, 27K ±10%, . 1/2 W	1	
-82	COMM	. RESISTOR, FIXED, COMPOSITION, 6.8K ±10%, . 1/2 W	3	
-83	COMM	. RESISTOR, FIXED, COMPOSITION, 330 ohms . . ±5%, 1/2 W	1	
-84	COMM	. RESISTOR, FIXED, COMPOSITION, 2.2 meg. . . ±10%, 1/2 W	1	
-85	COMM	. RESISTOR, FIXED, COMPOSITION, 2.7K ±5%, . 1/2 W	1	
-86	COMM	. RESISTOR, FIXED, COMPOSITION, 3.3K ±5%, . 1 W	3	

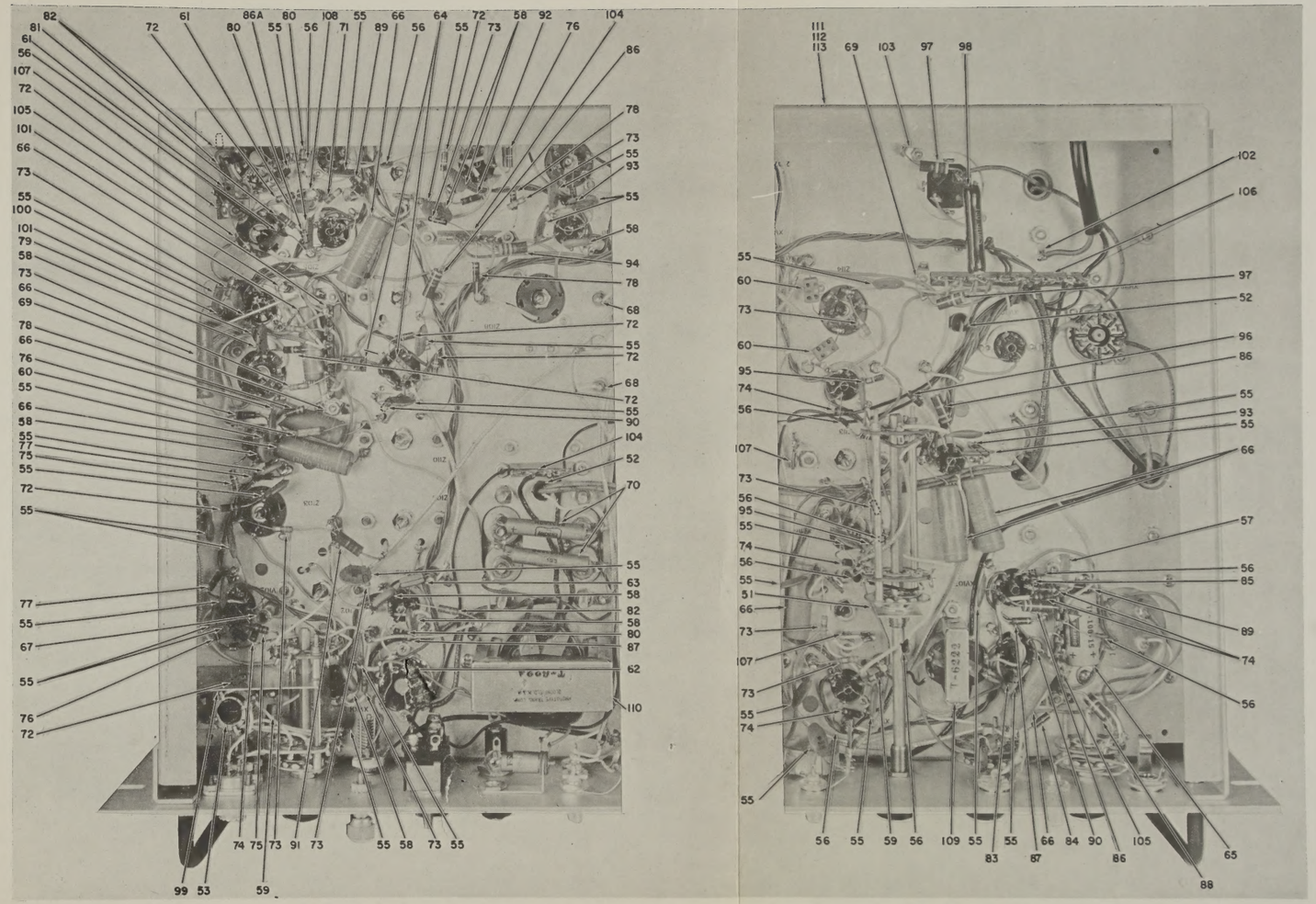


Figure 2-3. Chassis Assembly (Sheet 2 of 2)

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
2-3-86A	COMM	. RESISTOR, FIXED, COMPOSITION, 470 ohms . . . ±10%, 1/2 W	1	
-87	COMM	. RESISTOR, FIXED, COMPOSITION, 100 ohms . . . ±5%, 1/2 W	2	
-88	COMM	. RESISTOR, FIXED, COMPOSITION, 10K±5%, 1 W .	1	
-89	COMM	. RESISTOR, FIXED, COMPOSITION, 120K . . . . . ±10%, 1/2 W	2	
-90	COMM	. RESISTOR, FIXED, COMPOSITION, 200 ohms . . . ±5%, 1/2 W	2	
-91	COMM	. RESISTOR, FIXED, COMPOSITION, 6.8K±10%, 1W	1	
-92	COMM	. RESISTOR, FIXED, COMPOSITION, 82 ohms . . . ±5%, 1/2 W	1	
-93	COMM	. RESISTOR, FIXED, COMPOSITION, 68 ohms . . . ±5%, 1/2 W	2	
-94	COMM	. RESISTOR, FIXED, COMPOSITION, 33K±5%, 1 W .	1	
-95	COMM	. RESISTOR, FIXED, COMPOSITION, 150K ±10%, . 1/2 W	3	
-96	COMM	. RESISTOR, FIXED, COMPOSITION, 10K ±10%, . . 1/2 W	1	
-97	COMM	. RESISTOR, FIXED, COMPOSITION, 470K ±10%, 1W	2	
-98	1-3/4-D-57-F	. RESISTOR, VITREOUS ENAMELED, Wirewound, . 150 ohms ±5%, 10 W (44655)	1	
		(ATTACHING PARTS)		
	CS211-632	. SCREW, MACHINE, PAN HEAD, CROSS- . . . . RECESSED	2	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH . . . . . LOCKWASHER	2	
		---*---		
-99	1444	. SHIELD, COIL.	1	
-100	1443	. SHIELD, SOCKET	1	
-101	765	. STAND-OFF (80035)	4	
		(ATTACHING PARTS)		
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH . . . . . LOCKWASHER	1	
		---*---		
-102	2103-08-00	. TERMINAL, SOLDER (78189)	3	
-103	2104-06-00	. TERMINAL, SOLDER (78189)	5	
-104	1892	. TERMINAL STRIP, 6-lug (71785).	2	
-105	1560-A	. TERMINAL STRIP, 8-lug (71785).	2	
-106	2010	. TERMINAL STRIP, 10-lug (71785)	1	
		(ATTACHING PARTS)		
	CS210-45	. SCREW, MACHINE, PAN HEAD, SLOTTED . . .	2	
	CS270-1	. NUT AND CAPTIVE EXTERNAL TOOTH . . . . . LOCKWASHER	2	
		---*---		
-107	1513-A	. TERMINAL STRIP, 2-lug (71785)	18	
-108	1529-A	. TERMINAL STRIP, 3-lug (71785)	2	
-109	1506	. TRANSFORMER, Output	1	
		(ATTACHING PARTS)		
	CS210-66	. SCREW, MACHINE, PAN HEAD, SLOTTED . . .	2	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH . . . . . LOCKWASHER	2	
		---*---		
-110	1507	. TRANSFORMER, Crystal oven power	1	
		(ATTACHING PARTS)		
	CS270-66	. SCREW, MACHINE, PAN HEAD, SLOTTED . . .	2	
	CS270-2	. NUT AND CAPTIVE EXTERNAL TOOTH . . . . . LOCKWASHER	2	
		---*---		
-111	1499	. NAMEPLATE (mounted at rear of chassis)	1	
-112	C-7941-832-3B	. RETAINER AND LOCKNUT (78553) (mounted . . . at rear of chassis)	2	
-113	1448	. CHASSIS	1	